GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL

[ ] REVISION NO. ____

Project No. A-2995 DATE: 7/28/81

Project Director: Craig J. Wyvill School/Lab TAL/AED

Sponsor: State Board of Education of the State of Georgia, Atlanta, GA

Type Agreement: Unnumbered agreement dated 6/11/81

Award Period: From 6/11/81 To ~~3/30/~~82 (Performance) 2/15/82 (Reports

Sponsor Amount: $75,000 ~~9/31/82~~ 9/15/82 Contracted through:

Cost Sharing: N/A GTRI/GIT

Title: An Advanced Technology Study for Postsecondary Area Vocational - Technical Schoo

ADMINISTRATIVE DATA OCA CONTACT Leamon R. Scott

1) Sponsor Technical Contact: Mr. Robert Mabry, Research Coordinating Unit Division of Program Development, Office of Vocational Education; Georgia Dept. of Education; Room 333, State Office Bldg.; Atlanta, GA 30334

2) Sponsor Admin./Contractual Contact: John J. Milkowski, Contracts Officer; State of Georgia Dept. of Education; Office of Administrative Services; State Off. Bld; Atlanta, GA 30334

Reports: See Deliverable Schedule Security Classification: N/A

Defense Priority Rating: N/A

RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirem

Travel: Foreign travel must have prior approval - Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with sponsor.

COMMENTS:

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting Office
Procurement/EES Supply Services

Research Security Services
✓ Reports Coordinator (OCA)
Legal Services (OCA)

EES Research Public Relati
Project File (OCA)
Other: ____

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 10/5/82

Project Title: An Advanced Technology Study for Postsecondary Area Vocational Technical Schools

Project No: A-2995

Project Director: Carol Aton

Sponsor: State Board of Education, Georgia

Effective Termination Date: 9/15/82

Clearance of Accounting Charges: __________

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and Closing Documents
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other __________

Assigned to: TAL (~~School~~/Laboratory)

COPIES TO:

RAN ~~Administrative Coordinator~~
Research Property Management
Accounting
Procurement/EES Supply Services

Research Security Services
Reports Coordinator (OCA)
Legal Services (OCA)
Library

EES Public Relations (2)
Computer Input
Project File
Other GTRI

FORM OCA 10:781

A-2995

AN ADVANCED TECHNOLOGY STUDY FOR POST-SECONDARY AREA VOCATIONAL-TECHNICAL SCHOOLS

Interim Report

for

Research Project A-2995
Office of Vocational Education
Georgia Department of Education
Division of Program Development
Atlanta, Georgia

Prepared by

J.C. Wyvill, Project Director
R.D. Atkins
C.L. Aton
J. Banks
D. Betten
H.W. Hodges
G.E. Kearney
R.G. Schwartz
J.L. Walsh

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia 30332

October 1981

ACKNOWLEDGEMENTS

The authors wish to acknowledge the timely cooperation of the area school directors and teachers as well as the knowledgeable assistance of staff in the Office of Vocational Education. A special thanks goes to Robert K. Mabry, our Technical Coordinator, for his professional support of our efforts.

NOTICE

This document is an interim report. It presents a summary of our findings to date with our preliminary recommendations on major issues. This report is intended to be a working document and is subject to further clarification and future modification based on the reviews which will follow.

TABLE OF CONTENTS

		Page
SECTION I	Executive Summary	1
SECTION II	The Future of Advanced Technology and its Implications for Georgia	8
SECTION III	The Identification of Needs for the Vocational-Technical System to Support Advanced Technology Growth	23
SECTION IV	An Assessment of the Vocational-Technical System Structure in Georgia and its Impact on Advanced Technology Response	35
SECTION V	Recommendations	70
APPENDIX A	Engineering and Science Technician Qualifications	79

SECTION I
Executive Summary

The objective of this study is to determine how the post-secondary vocational-technical system in Georgia can best fulfill the training needs of high technology industry over the next two decades and how the system can provide a competitive edge in attracting this fast-paced high growth industry to our state.

Seven general industrial categories fit our definition of high technology:

Computer/Computer Services

Communications

Avionics

Robotics/Automation

Fiber/Laser Optics

Biology

Solar Energy

A survey of 20 firms in the Southeast who employ vo-tech graduates showed that although the system is working reasonably well, there are a number of problems that need to be addressed. Basic equipment is out-of-date with limited funds for replacement. Teachers are not given sufficient opportunities to spend short periods of time in industry and learn first hand about the latest technological changes. Vocational education still has an image of "trade school" despite a heavy demand for skilled technicians who can troubleshoot complex equipment and make a very respectable entry level salary.

The vo-tech system cannot respond quickly enough to rapidly changing needs within program areas, and some deficiencies in entry level skills were pointed out.

An analysis of the Georgia vo-tech systsem showed that school directors and teachers were very much aware of the shortcomings within their system. All of the school directors were surveyed by mail and nine of the schools were visited. Of the 17 barriers proposed by the survey, lack of equipment and teachers' salaries were perceived by all directors as major hindrances to the implementation of high technology programs. Other barriers designated by many of the directors included certification requirements for teachers, updating of skills, and leadership at the state level.

To determine how competitive Georgia is with other states, we looked at vo-tech systems in California, North Carolina, and South Carolina. All have made major commitments to the training needs of high technology industry. California trains their technicians in community colleges, which have a separate governing board created in 1968. The California Worksite Education and Training Act (CWETA) was passed in 1979 to satisfy electronic leaders' pleas for a more responsive educational effort. North Carolina recently moved secondary and post-secondary vocational programs from the State Board of Education to the State Board for Community Colleges. Many of the critical need programs identified for the 1981-1983 biennium are high technology related. In addition, North Carolina's Governor has provided $30 million for a microelectronics center, which has already attracted General Electric to the state. South Carolina's vo-tech system is governed by the State Board for

Comprehensive and Technical Education. Their "Design for the Eighties" concept establishes five resource centers in high technology and a Coordinator of Innovative Technical Training to spearhead their effort.

Other states have not completely solved their problems in high technology training, and Georgia still remains on the list of sites to be considered for locating new technology industry. The nucleus of electronics and communications industries already in our State includes Hewlett-Packard, Scientific Atlanta, and Marconi Avionics as well as the Warner Robins Air Force Base which purchased $1.5 billion of high technology products in 1980. In addition, the State has established an Advanced Technology Development Center (ATDC) at Georgia Tech.

But how can Georgia remain competitive in attracting and retaining an industry with an insatiable need for skilled technicians, the type of worker trained by our vocational-technical school system? To continue attracting and retaining high technology firms, the post-secondary vocational-technical system in Georgia must make some adjustments to deal with the unique requirements of high technology industries. These adjustments should be made to react to both current and projected shortcomings in the system. Six major problems have been identified along with our proposed solutions. These are presented below.

****

PROBLEM: Equipment for those programs offering the highest employment potential are outdated or non-existent in many schools.

PROPOSED SOLUTION: Upgrade electronic equipment to a basic minimum standard. Develop an equipment sharing program for high cost items.

****

Georgia must upgrade the equipment and instrumentation in the vocational-technical schools to reflect current technological needs. This can be accomplished by upgrading each school to a selected minimum level and offering expensive equipment on a sharing basis. The approximate costs of such an upgrading approaches $6 million.

****

PROBLEM: The vo-tech system is able to attract few qualified teachers in rapidly expanding fields because of competition with industry, and those few are given insufficient opportunities to upgrade their technical skills.

PROPOSED SOLUTION: Increase teacher salary ranges to a level commensurate with their marketplace value. Reduce teacher workload to allow for periodic leaves of absence to work in industry and attend technical training sessions. Utilize industry personnel as guest instructors.

****

Vocational-technical schools must be able to acquire and retain qualified teachers possessing critical technical skills. This requires a change in the pay scale for vocational-technical teachers which more accurately reflects their worth in the industrial marketplace. Furthermore, additional teachers must be hired to support a growing need for more high technology programs to meet industry demands for qualified graduates and to allow more time off for technical updating. The combined cost of paying higher salaries and hiring more teachers could result in an expanded teacher payroll of nearly $3.8 million annually.

****

PROBLEM: The vo-tech system currently lacks a beacon to industry showing commitment to high technology needs.

PROPOSED SOLUTION: Design and implement a model school on the cutting edge of those technologies with the greatest economic impact on the State of Georgia.

****

An important concept in quickly adjusting to meet the high technology challenge is to create a "model school" in the Georgia vo-tech system that contains the latest equipment, experiments with the latest curricula, and constantly interfaces with high technology industries across the country. This school can either be located in an existing or planned facility in the system or can be designed and planned as a brand new unscheduled facility. Economics favor the use of a facility currently in the planning or construction phase. Its location should be in the heart of a region where rapid advanced technology growth is projected.

The model school serves as a physical commitment of Georgia to meeting the needs of high technology. It also serves as a catalyst for a more responsive system by supporting high technology program growth throughout the vo-tech system. An order of magnitude estimated for the necessary design changes and equipment purchases that would be needed to allow the conversion of an existing facility is $10 to $15 million. The cost of a totally new facility would be in the neighborhood of $25 million.

****

PROBLEM: The vo-tech system requires technical leadership to unify its approach to the challenge of future training needs.

PROPOSED SOLUTION: Establish a steering committee to define and direct vo-tech response to changes in high technology.

****

Georgia desperately needs an advanced technology steering committee to direct and define the response of the post-secondary vo-tech system to high technology needs. The committee, unlike any currently in existence, should be composed of experts on industrial and educational innovations as they relate to advanced technology growth. This "working" committee should report directly to the Governor and should be headed by an impartial third party knowledgeable on both technological and educational matters. The committee would provide a bipartisan critique of how the system is performing and where the system needs to move.

****

PROBLEM: Current program offerings in the vo-tech system do not reflect forecasted employment opportunities over the next two decades.

PROPOSED SOLUTION: Implement fiber/laser optics and biology programs in order to strengthen our ability to attract these potential industries.

****

Although Georgia is not viewed as a center for genetic engineering, Emory University and the University of Georgia are conducting major research in this area. Projections show that 160 jobs will be available annually from 1985 to 1990 and 450 annual openings from 1990 to 2000. Western Electric's work in applications of fiber optics and laser research by Georgia Tech, military centers, and private corporations in the state should stimulate growth in the area of fiber/laser optics. Employment projections are 315 average annual openings for 1985 to 1990 and 800 average annual openings from 1990 to 2000.

Outstanding job opportunities already exist in computer/computer services, communications, avionics, and robotics/automation; and these opportunities are expected to grow significantly over the next two decades. Programs currently offered by the vo-tech system, however, can be supplemented by additional courses and specialized training to meet these needs.

****

PROBLEM: The growth of high technology will result in a greater demand for technicians with a broader base in related subjects and a deeper understanding of their own fields.

PROPOSED SOLUTION: Implement a two-year associate degree program within the vo-tech system and establish joint curricula with the junior colleges.

****

The vo-tech system is a good vehicle for fulfilling the growing need for engineering/scientific technicians. These technicians generally earn a two-year associate degree and any vo-tech program should be coordinated with the junior college system to allow the necessary infusion of academic skills. However, the vo-tech school system offers the proper industrial orientation to administer this program. Currently there is a shortage of these technicians and projected high technology growth points to an ever widening gap between supply and demand for this talented but practical technician.

SECTION II
The Future of Advanced Technology and its Implications for Georgia

Introduction

A critical question from the outset was how to define advanced technology. Based on a definition provided by K. Nagaraja Rao, a Senior Research Associate at M.I.T., we were able to characterize high technology in relative terms.* The characteristics of high technology are as follows:

(1) a process which is knowledge based;

(2) an area where there is a relatively intense concentration of technical skills and knowledge;

(3) a system which integrates scientific knowledge within the production system, reinforcing innovative activity and mobilizing technical resources;

(4) a procedure which is coupled with a high level of research and development (R and D) effort and actively incorporates new concepts and ideas which flow from the R and D;

(5) a concept which is radically new in its scientific and technical content; and

(6) a process which incorporates an advanced level of automation in manufacture and production control.

---

*For example, a multipurpose tractor may be a symbol of high technology in the rural areas of some developing countries, whereas, to most of the developing world, a tractor does not symbolize sophisticated technology.

This definition led to the identification of seven general industrial categories all of which fit the designation of advanced technology:

computer/computer services

communications

biology

solar energy

fiber/laser optics

robotics

avionics

Identifying the future of advanced technology in Georgia is no easy task. High technology areas are changing so rapidly and overall growth trends span such short time intervals that a uncertainty quickly enters forecasts. Using documented employment studies and sales projections formulated from numerous sources, however, we were able to project the potential employment impact of high technology growth in Georgia. Where possible, specific employment studies were cited.

Three scenarios for sales increases were established--"low," "most likely," and "high." Sales output per worker data was collected from representative high technology companies. Projected sales increases were then divided by output per worker to determine the number of production workers needed to reach the projected sales levels. Basic assumptions made were that production workers comprise 85% of the corporate workforce and that sales output per worker for specific industries will remain constant over the next 20 years.

National projections were compared with technological and industrial trends in the State of Georgia. Based upon the current manufacturing establishment, the state's technological trends, and industry participants, Georgia employment projections were estimated at a percentage of expected national growth. Georgia represents 2% of the national population; this was utilized as "following the national trend." Weights were then added or subtracted according to each factor: the current manufacturing base, the state's technological and industrial trends, and the advice of industry leaders. Table 1 summarizes most likely average annual job openings in Georgia for the seven areas which are discussed in detail below.

Computer/Computer Services

A. Computer

The computer industry as defined herein includes mainframe computers, super computers, mini and micro computers, word processing microcomputers and peripheral equipment (terminals, memories, printers, and others).

Computer software is lagging behind the hardware because of the tremendously fast pace of the hardware development and because of the shortage of highly trained individuals who can work in this area. The hardware is becoming faster and smaller but in many cases can require more sophisticated software to enable it to have the flexibility desired. As more computers are in use the need for good software may grow exponentially. The microprocessor is requiring personnel who have a firm grasp of both software and hardware because of the its symbiotic nature.

Table 1
Projected Job Openings in Georgia
For High Technology Industry

Years	Rank	Technology	"Most Likely" Average Annual Job Openings
1980-1985			
	1.	Computer/Computer Services	4,872
	2.	Communications	1,884
	3.	Avionics	800
	4.	Robotics/Automation	643
	5.	Fiber/Laser Optics	170
	6.	Biology	80
	7.	Solar Energy	9
1985-1990			
	1.	Computer/Computer Services	5,472
	2.	Communications	3,475
	3.	Avionics	1,074
	4.	Robotics/Automation	848
	5.	Fiber/Laser Optics	315
	6.	Biology	160
	7.	Solar Energy	20
1990-2000			
	1.	Communications	7,220
	2.	Computer/Computer Services	6,222
	3.	Avionics	1,713
	4.	Robotics/Automation	1,244
	5.	Fiber/Laser Optics	800
	6.	Biology	450
	7.	Solar Energy	93

National sales projections are based on the Standard and Poor's Industry Survey for the computer/computer services industries. Each market segment has different projected growth rates. However, the weighted composite growth rate for the industry is approximately 13%. This is used as the "most likely" growth rate for sales. The periodical, Control Engineering, quoted a five year 18% growth projection, which is used as the upper bound. Few expect this explosive industry to grow at less than 10%, thus it is used as a "lower" bound. The skew is toward the low end.

Sales output per production worker was calculated from IBM, DEC, Commodore, and Cray Research to yield a composite sales output of $60,000 per production worker. This figure was then divided into national sales projected sales increases to determine the number of new manufacturing employees required to reach those sales levels. "Low," "most likely," and "high" national employment scenarios are thus determined.

Georgia has been running slightly behind the national trends in the computer industry. However, Georgia has a number of significant advantages. The state government is pursuing the electronics industry and Georgia should attract several larger semiconductor manufacturing plants because of favorable labor conditions. Atlanta is an important transportation center and provides rapid input and output for the small electronic components required. One of the major manufacturers, Lanier Business Products, Inc., is located in Georgia. There is a growing market for high technology in Georgia and in the Southeast. Georgia remains a "right-to-work" state.

Because of these trends, Georgia is seen as growing in computer manufacturing employment, but slightly behind the national surge. Georgia's "most likely" computer employment growth is projected at 1.5% of the national growth or 1,950 new jobs annually between 1980 and 1985; 2,550 new jobs annually between 1985 and 1990; and 3,300 new jobs annually between 1990 and 2000. The variance scenario is projected at $\pm$ .5%, or 1% of new employment as the "low" scenario and 2% of new employment as the "high" estimates.

B. Computer Services

Computer services includes data processing services, professional data management consulting services, and software products. The Bureau of Labor Statistics has projected national trends to the year 1990 in their Occupational Outlook Quarterly. Based on this report, annual openings are projected to the year 2000.

Georgia is in an excellent position to take advantage of employment growth in this industry. Atlanta has a solid base of computer service firms and is the headquarters for many corporations which require computer services. Technicians are needed to install and service the growing investment of computers in the state. Georgia's institutions are training a healthy number of computer science graduates who are in demand both inside and outside of Georgia.

Thus, employment growth in computer services is projected above the national trend at 3% of the total growth. The "low" estimate is projected at 2% of total growth and the "high" estimate at 4%. A variance of 1% is utilized because of the larger number of employees involved. The "most likely" scenario translates into 2,922 service jobs annually over the next 20 years for Georgia. Among the five major occupations--systems analyst, programmer, operator, keypunch operator, and service technicians--operators will be the highest growth in numbers while service technician jobs are expected to grow the fastest.

Communications

Communications includes satellites, terrestrial services (tele-communications, cable television, electronic mail, etc.), and related fiber optic technology.

IBM's satellite communications subsidiary, Satellite Business Systems, has forecasted 8.3% sales growth from 1980-1985 and 15% sales growth from 1985-1990 for the business communications market. The 8.3% figure is utilized as our "most likely" projection, bounded by 5% as the "low" growth projection and 10% as the "high" growth scenario. These projections are skewed toward the "high" end. For the following five years 15% is taken as the "high" projection, 10% as the "most likely" estimate, and 5% sales growth is the "low" growth estimate. The Predicasts, Inc., listed one estimate at a $166 billion dollar market by 1995, or 10% annual growth following 1985.

Both Scientific Atlanta and Teleprompter are used to represent sales output per production worker and show sales output per production worker at $56,000. Given the above assumptions, best estimates for national openings are 62,800 average annual new jobs between 1980 and 1985; 115,800 average annual new jobs between 1985 and 1990; and 481,400 average annual opening between 1990 and 2000.

Georgia should capture more than its share of new employment in communications. The "most likely" estimate is 3% of the national growth, 4% is optimistic, and 2% is the "low" estimate. The "most likely" estimate indicates 1,884 annual job openings between 1980-1985; 3,475 annual job openings between 1985-1990; and 7,220 annual job openings between 1990-2000.

Communications is Georgia's largest high technology employer: Georgia can boast of Scientific Atlanta (satellite and cable TV equipment), Western Electric Atlanta Works (advanced fiber optics), and Continental Telephone (total communications network) among others. The cable television market is growing rapidly. Atlanta appears to be a natural marketing distribution center.

Biology

Biology includes genetic engineering, bio-engineering, and electronic medical equipment.

Genetic engineering sales are difficult to predict. Sales are estimated to reach into the billions, but when and if this will occur is difficult to predict. International Resources Development, Inc., a market research firm, estimates sales to reach $520 million by 1985 and $3.14 billion by 1990. These estimates are used as the "most likely" along with the Office of Technology Assessment's year 2000 estimate of $7.2 billion (Impacts of Applied Genetics: Micro-Organisms, Plants and Animals).

Sales of electronic medical equipment are forecast by Predicasts at $5.1 billion in 1985 and $11.5 billion in 1995, an annual growth rate of 9.7%.

This growth rate is used to arrive the 1990-2000 year estimates ($8.1 billion in 1990 and $19.9 billion in 2000). Employment in bio-engineering (artificial body parts) does not appear to be significant in numbers.

Abbott Laboratories is a representative of the industry with sales output per worker at $70,500. The nation is therefore estimated to need 39,300 workers in this area over the years 1980-1985, 79,500 workers over the years 1985-1990, and 224,000 new workers over the years 1990-2000.

Georgia does not have a current manufacturing base for either recombinant DNA products or medical electronic equipment. Emory University and the University of Georgia are doing important research. However, Georgia is not viewed as a center for genetic engineering. Therefore, it is estimated that biology will employ few workers in Georgia relative to national trends, or 1% of the total growth. The "low" estimate is .5% and the "high" estimate is 1.5% of national growth. The median estimate calls for averages of 80 annual job openings 1980-1985, 160 annual openings 1985-1990, and 450 annual openings 1990-2000.

Solar Energy

Solar energy includes solar thermal energy, active and passive, and photovoltaic solar cells.

Solar thermal energy sales are currently growing at 20% per year, while photovoltaic sales are increasing 30% annually. Bill Schwendler, southeastern regional manager for the Grumman Corporation, expects these growth rates to represent the "high" scenario. He projects that the "most likely" growth rate for photovoltaic sales is 20%. The "low" boundary for both industries is a conservative 10% annual growth projection.

Ametek is a representative of the industries with a $63,000 sales output per worker. It is thus estimated that only 4,700 new production workers will be needed between 1980 and 1985, 10,100 between 1985 and 1990, and 61,700 between 1990 and 2000.

Georgia has more disadvantages than advantages for growth in this technology. Although Georgia has an excellent climate for collecting solar energy and space heating, our relative energy costs are much lower than the majority of states and cause solar energy to be currently uneconomical. High initial solar costs, high interest rates, and few tax incentives have also slowed the growth of solar energy in Georgia, according to Bill Schwendler. Florida is one of the leaders in solar energy, providing difficult competition. Therefore, solar energy is expected to demand the fewest new jobs among the seven technological areas in this document. Employment growth is estimated at 1% of the national growth until 1990. It is expected that eventual tax incentives will push growth to 1.5% of the total. However, this only represents an increase to 93 average annual openings for the state for 1990-2000.

Fiber/Laser Optics

Fiber optics includes applications such as computer interconnections, computer writing, and military uses. This section excludes the use of fiber optics in communications.

Gnostic Concepts, Inc., a market research firm, has projected the fiber optics market to the year 1990. The next five years should witness an explosive 55% increase in fiber optic system sales. After 1985 Gnostic Concepts predicts a slower growth rate of 10% for the market. Our study extends that growth rate to the year 2000 because of demands for and decreasing costs of fiber optic systems.

Lasers include commercial, industrial, and military applications. Markets for lasers are growing rapidly. The periodical Laser Focus projects 28% sales growth rates over the years 1985-1990. As the market increases over the $10 billion level, growth rates should slow to 15%, which is still robust growth, to the year 2000.

Valtec, Inc., is used to represent the sales output for fiber optics workers at $80,000 sales output per production worker. Spectra-Physics is representative of laser manufacturers with a $71,000 sales output per production worker.

Important laser research is being conducted in the state by Georgia Tech, private corporations, and the military. Western Electric's Atlanta Works should be a stimulus to applications in fiber optics in addition to communications. On the other hand, industrial lasers and advanced non-communication fiber optics applications are finding greater use in the more industrialized states. It is therefore predicted that Georgia will follow the national trend with 2% of the overall employment growth in fiber/laser optics. "Low" estimates call for 1.5% of the growth and "high" estimates predict 2.5% of national growth to be in Georgia. If Georgia follows national trends, 170 average annual job openings are predicted for 1980-1985, 315 average annual openings for 1985-1990, and 800 average annual openings for 1990-2000.

Robotics

A. Industrial Automation

Robot system sales include both the mechanical hardware and the software necessary for operation.

BusinessWeek projected two scenarios for robotic sales: one if current suppliers continue to dominate the market and another if computer companies (IBM and TI) enter the business. If current suppliers dominate the market, then BusinessWeek estimates a $300 million market in 1985 and a $800 million market by 1990.

Peter Blake of Executive Robotics, Inc., in Michigan has stated that the entrance of IBM and TI into the market within the next six months is now not a secret in the industry. BusinessWeek predicts that if these computer companies moved into the robotics market, then 1985 sales should jump to $450 million and 1990 sales to $2 billion. These figures are optimistic and are viewed as the "high" scenario. Estimates assuming current suppliers will dominate the market represent a "low" scenario. The "most likely" outcome will probably fall somewhere between the two; the medians of $375 million in 1985 and $1.4 billion in 1990 are used as the "most likely" scenario.

The two major current suppliers, Cincinnati Milacron and Unimation (subsidiary of Condec), both have a sales output per worker of $69,000. This translates into 4,275 projected job openings from 1980-1985, 14,825 from 1985-1990 and 32,300 from 1990-2000.

Georgia currently has a few robotics research firms but no manufacturing base. The industry is dominated by four companies with most robots being used in heavily industrialized states. The only advantage Georgia has is its attractive labor situation, but few if any workers are trained in robotics.

Therefore, it is predicted that Georgia will capture 1% of the national growth. The "low" scenario is 0.5% and the "high" prediction is 1.5% of national employment growth. This does not mean tremendous employment: 43 are the production workers needed from 1980-1985, 148 more from 1985-1990, and 324 new workers from 1990-2000. Robot service technicians represent greater potential for new employment. However, their demand is too difficult to predict at this time for Georgia.

B. Office Automation

Office automation includes copiers and "intelligent" printers. (Computers, word processors, and electronic mail are covered in other sections of this document).

Standard and Poor's has forecasted explosive growth for the office automation industry. Plain paper copiers (PPCs) are expected to grow 16.7% over the next five years. This forecast is extended at 10% from 1985-1990 and at 7.5% from 1990-2000. "Intelligent" copiers are expected to grow from $400,000 sales to $1 million by 1985. This forecast is extended at 20% annual growth from 1985-1990 and 7.5% annual growth from 1990-2000. As defined, office automation equipment represents a $48 billion market by the year 2000.

Xerox is a representative of the industry with a sales output per worker of $80,000. This translates into 100,000 new jobs over the period of 1980-1985, 117,000 new jobs over the period of 1985-1990, and 309,000 new jobs from 1990-2000.

Georgia is in an excellent position to take advantage of this booming industry. Lanier Business Products has demonstrated the growth opportunities that are available in this field for Georgia. Atlanta is the largest business center for the growing southeast.

It is predicted that 3% of the national growth or 600 average yearly openings would be available from 1980-1985. From 1985-1990 yearly openings are estimated to increase to 700. Over the ten year period of 1990-2000, Georgia would need 920 new production workers per year to keep up with the demand. The "low" scenario is set at 2% of national employment growth and the optimistic prediction at 4%.

C. Avionics

Avionics includes electronic warfare, guidance, takeoff, and leading instrumentation and surveillance for military and commercial airplanes, missiles and space vehicles.

Standard and Poor's states that avionics sales in 1980 were placed at $16 billion, up from the previous year's $14 billion. The Electronic Industries Association in its fiscal years 1980-1990 forecast of defense markets has estimated that spending for electronics in Defense Deptartment aircraft programs will increase from the current level of $4.8 billion to $6.7 billion in 1990 (avionics equipment comprises the majority of the military electronics market). The Association also predicted Defense spending for missile electronic systems during the same period would increase from $3.2 billion to $6.7 billion and that spending for electronic systems for Defense space programs would jump from $1.8 billion to $5.1 billion.

The commercial avionics market, including electronic instrumentation and guidance systems for commercial aircraft, was at the $1 billion level in 1980. Standard and Poor's states that the commercial avionics market should show only moderate progress because of softening general aviation aircraft demand. Therefore, the "most likely" scenario for the commercial market is 5% annual growth and 2% as "low" growth.

E-Systems, Inc., has a sales output per production worker of $44,000 and is representative of the industry. Military avionics will account for most of the estimated 134,000 new jobs between 1980-1985 across the country. The openings should rise to 179,000 jobs between 1985-1990 and reach 571,000 during the ten year period 1990-2000.

Georgia has an excellent manufacturing base in avionics and should prosper from military spending over the next 20 years. Loral, Marconi, and Lockheed are all active in avionics employment. Georgia's military bases and commercial airlines also provide nearby users for avionics equipment.

If Georgia captures 3% of the national markets, then 800 production workers will be needed annually between 1980-1985, over 1,000 annually between 1985-1990 and over 1,700 annually between 1990-2000. The "low" estimate is a conservative 2%; the "high" estimate 4% of the low national level.

SECTION III
The Identification of Needs for the Vocational-Technical System to Support Advanced Technology Growth

Introduction

We approached the task of identifying areas that needed strengthening in the vo-tech system by studying problems raised by both industry and school system representatives. Teams of researchers contacted twenty firms in the southeast already using or producing advanced technology equipment or components. Likewise, 28 schools in the Vocational-Technical (Vo-Tech) System were surveyed and knowledgeable individuals both in the Georgia education system and other state education systems were interviewed regarding the manner in which Vocational-Technical education has responded to advanced technology needs.

In general, our investigations found a system working reasonably well. Industry and the vocational-technical schools were working together to do what they could to maintain vo-tech programs at a level supportive of industry needs. With regard to advanced technology, however, there were areas which hampered the responsiveness of the system to industry and which often led to criticisms of it. These areas are discussed in this section with regard to current and future needs and their implication on the system.

Evaluation of the Current System

Generally, industry and the vo-tech system are working together very well. In fact, most industries appeared to be more than willing to do whatever is necessary to improve vo-tech programs in their area. Many firms contacted either had or felt as though they could contribute something to the vo-tech program if called upon to do so.

Most of the larger firms contacted had already begun to establish some sort of training program to fill in the knowledge voids found in their employees either through omission in their training or due to new developments. Within the high technology area, training can quickly become obsolete. Progressive companies and individuals recognize this and constantly stress the need for additional training programs. Industry knows its employees cannot keep up with technology unless they in turn provide them with the opportunity. On the other hand, vo-tech instructors cannot be expected to teach state-of-the-art technology without continuing their education and continuing their interaction with industry. The instructor must be committed to this type of progressive program.

These ideas of education and industry interaction were important five years ago but they are an absolute necessity now in most areas of high technology. If vo-tech schools are to provide manpower which meets the needs of industry they must address this interaction.

One of the most frustrating aspects of identifying needs in the current system is addressing the area of skills that industry found lacking in vo-tech graduates. The mix of skills needed for advanced technology support are many indeed. Table 2 depicts a partial listing of job titles for which vo-tech graduates are needed by advanced technology firms. The skills required to perform these jobs (as written in the personnel job descriptions) were found to vary from company to company for the same general job title (see Table 3). Job titles and descriptions, in most instances were found to vary significantly from the Dictionary of Occupational Titles (DOT) classifications. Obviously, this implies that it is impossible for vocational-technical schools to always produce graduates who are perfectly trained for individual company needs. The vo-tech schools must however insure that the basic skills upon which firms can quickly orient graduates to individual job specialties are taught. Generally, this is what the vo-tech system is doing.

Some of the current high technology problem areas in the vo-tech system that were identified from our investigations were:

A. Equipment - Much of the basic equipment being used in the schools today is seriously out-of-date. Teachers have been able to purchase only minimal replacement equipment due to limited funds. In some schools industry has donated equipment. Each school must have up-to-date equipment to establish the baseline skills in key areas. The objective is to produce a graduate with a solid set of basic skills making him ready for specialized industrial training.

B. Teachers - High technology teachers constantly need to be sent to industrial or special schools for updating their knowledge. Many teachers use local industry contacts or periodicals to remain abreast of the new technology. However, teachers must be provided an opportunity to receive the latest in industrial education if they are to remain current in their field. Furthermore, every effort must be made to keep and retain good teachers. Often schools have been unable to hire or retain specialists in a given subject area either because salaries were too low or teacher certification requirements were too inflexible.

C. Poor Image - Vocational-technical education is still considered by some to be an alternative for those who cannot make it in college. This hurts the ability of the schools to attract good students. The new technologies require intelligent and energetic students many of whom are also college material. The system requires a major image revision to enhance the status of the vo-tech school to prospective students. Many major industries support this idea very strongly.

D. Responsiveness to Change - In order for the vocational-technical schools to keep up with rapidly changing technology they must be able to install new courses and programs quickly. Taking two to five years to create, test, and place a curriculum for a new program or course is a serious problem with respect to high technology. Suggestions by industry to speed the process include using more of the many educational courses and textbooks already on the market covering high technology subjects. It was argued that instead of starting from the beginning in developing a new course more effort should be made to interface developed packages into existing programs.

E. Enrichment and Tailoring of Programs to Changing Needs - While new curricula are provided schools by the Division of Program Development to assist vo-tech teachers in organizing courses, industry commented that in many cases some of the better vo-tech programs had instructors teaching from many different sources, some of which are not in the curriculum developed by the state. While the information in the state curriculum is usually complete, comments were received that it is not always in a form which the instructor can use for effective presentation. Therefore some of the instructors must personally seek other sources to enhance their educational material. In order to accommodate this need, suggestions were made that the state issue a list of supplemental text and audio/video aids in various high tech areas which reflect up-to-date advances or changes. Also it was suggested that instructors be allowed to spend more time at industrial sites and be exposed to the latest technology to enhance their understanding of new equipment and techniques.

F. Deficiency in Selected Skills Needed - Some electronics companies commented that vo-tech students completing an electronics technology program were often trained heavily in radio and T.V. repair and did not have the basic knowledge required to function as electronic technicians in their firm. Many industries give an entrance test which must be passed in order to be interviewed for a position. One firm said that only 10% of the vo-tech graduates interviewed passed its test. It was also commented that many of the ones that passed the entrance test had prior military or electronics experience prior to going to a vo-tech school.

Some companies lamented that the military source, which has been utilized for years, was drying up. There are fewer people coming out and the ones that do are not as well trained. The military response apparently is now to give specialized training in a very narrow area in the first six years of service. After that, those still in the service will be provided a broader-based and more in-depth background. As this military source continues to dry up, the need is going to outpace the supply very quickly.

The above reflects but one of several skill deficiencies found in vo-tech graduates by high technology industries. A consensus was not always reached about which skills were lacking but a list was generated covering the most common areas. That list is shown below:

1. No experience with latest machinery (CNC, etc.)
2. Poor interview skills
3. Not enough tooling and die instruction
4. No skill in maintaining records of testing and production work
5. Too little component soldering
6. No automated-machinery soldering
7. No integrated circuit insertion techniques
8. Very little inspection training
9. Not enough digital logic
10. Not enough microprocessors - design & use
11. Not enough interfacing (input/output, RS 232)
12. No training on advanced oscilloscopes (high frequency)
15. Hydraulics & pneumatics
16. Electrical control (programmable controllers, etc.)
17. Aircraft avionics

As can be seen from this list, some of these skills are supposed to be provided by the current programs. As was uncovered in our study, the problem is not that the instructors are unaware of these deficiencies but rather that many times equipment and instructional aids are not always available.

The major area where skills were lacking was in the area of electronic production assembly where such things as specialized soldering and integrated circuit insertion techniques take place. Skills were also found lacking with regard to electronic interfacing and microprocessor design. Only a few charges were made that more basic skills such as AC and DC theory, hydraulics, pneumatics, and electrical control were lacking.

Fortunately, none of the deficient skills identified above requires that a new program be put in place. Rather they call for the enhancement of existing programs coupled with some form of knowledge rating vehicle at the program's conclusion (such as standardized testing or some other such mechanism). Such upgrading should allow the system to be fully responsive to today's high technology needs.

One general comment by industry dealt with the need for not all courses to be presented in each school. For instance, they pointed out the possibility of using several schools as centers in producing high technology electronic technicians that are specialists in specific areas such as communications or digital equipment. They did not feel that it was necessary for each vo-tech school to try to achieve that goal. They argued that with the limited funds that are available, perhaps it would be better to try achieve a specialist level in several but not all of the vo-tech schools. At the same time industry did not want to see existing electronic courses eliminated from any school. This comment was based on their assessment of a long-term critical shortage of electronics-related technical personnel.

Most of the electronic companies were unable to fill their needs for technicians. In addition, concern was expressed in the area of certified aircraft airframe and power plant mechanics by both the airlines and the military. Only two Georgia technical schools have programs in this field, and demand is currently being filled by out-of-state graduates.

G. Training Programs - Comments were also received that the vocational-technical system should make better use of new types of instructional systems on the market (in audio and video cassette forms) which will enhance the capabilities of the vocational-technical instructor. In many cases this could lead to a stronger consistency between the type of graduate that is produced by different schools. These instructional systems, which are produced by master instructors, can be very efficient and productive. It is recognized that these tape presentations cannot take the place of basic hands-on experience with equipment in a lab environment. However, if currently available interactive systems were used, this would enhance both the classroom and laboratory instruction. This does not suggest the educational system should immediately begin producing its own instructional tapes unless it can be shown that the appropriate systems are not available in the open market. In many cases excellent videotapes are being produced by firms who are attempting to hire vo-tech graduates. For instance, Hewlett-Packard currently produces videotapes which are instructional in many different industrial areas. Some of these tapes are in the area of soldering, oscilloscope use, integrated circuit techniques, and troubleshooting. It was found that some of these videotapes are currently in use in at least one or two of the schools.

In talking to industry, it was revealed that videotape training programs were in use in most of the larger industrial firms which also have significant training departments. Many of the smaller firms contacted had no training personnel whatsoever but were still interested in utilizing some form of in-house training. In looking through the industrial literature it was found that the use of videotape programs in industry for training purposes is still in its infancy. More and more of the trade journals, however, discuss such training vehicles being used to increase the productivity of the workers and to train them for more advanced job situations. These programs are still not available to everyone, but where they are used results have been encouraging. For instance, one major firm estimated that they were giving training via classroom instruction and videotape presentations to their employees approximately 10% of the time. This number was arrived at by examining employee records of those who had been with the company for 10 years. It was calculated that the average employee in that firm received 50 weeks of training over this period. This is very indicative of what experts expect will be commonplace. More successful companies are learning that it is necessary to continually train and update their personnel. It may be that there is a place for the vo-tech system in the area of update training.

In visiting companies outside the State of Georgia we found no major complaints about the post-secondary vocational-technical schools in South Carolina, North Carolina, or Tennessee. Admittedly, we had a rather limited sample with five companies, but none of the 20 firms that were visited in Georgia were so kind. Looking at some of the transcripts of job applicants applying to these out-of-state firms, it was evident that the vocational-technical schools in North Carolina and South Carolina are providing courses in calculus and physics and other hard sciences which enabled the graduate to have a more fundamental scientific understanding of his skill area. It was revealed after talking to most industries in Georgia that they did not really feel this type of general background is extremely important in the jobs for which they were seeking vo-tech graduates. However, it is possible that by enriching the curriculum with specific science offerings that the qualifications of a vo-tech graduate will rise to a level which makes him more universally qualified among different firms.

One of the major conclusions drawn from our many interviews is that the success of a vo-tech program is <u>very</u> dependent on two items. The first is the presence of a capable, intelligent, progressive instructor for the subject area. The second is the presence of industrial firms in the general area of the school which uses the vo-tech graduates. This is not to say, however, that there are not good courses in all schools regardless of the neighboring industry. Rather it seems that these two items enhance each other in most cases. The part of the existing operation which needs improving, according to industry, is the need to require that the instructors spend more time in industry where they can keep up-to-date on the latest techniques and equipment. This is extremely important, and industry encouraged the state to support this type of cooperation. Some industry personnel said that this was being done in other states and was working very well.

Projected Needs to Support Advanced Technology Growth

In addition to studying areas of needed improvement in the existing vocational-technical system, we developed a list of areas that will impact the responsiveness of the vo-tech system as advanced technology industries continue to expand. The immediate future holds a challenge in the ever-growing demand that will exist for vo-tech graduates. This demand can be expected to place a strain on vo-tech schools to attract and retain a sufficient number of qualified students. Facilities will have to be expanded to meet the increased number of students trained, and more teachers will be needed to handle the increased workload.

Within the next 10 years, two new program offerings may be necessary to respond to new advanced technology areas which are expected to evolve in Georgia: Fiber/Laser Optics and Biology. In addition, advanced technology firms will continue to place a growing demand for engineering and scientific technicians (see Appendix A for a description of typical qualifications). While

Georgia's vo-tech schools currently do not offer programs in this area it is expected that this demand will provide a unique opportunity for the vocational-technical system to expand its program offerings into an area that is badly needed by industry and which strengthens the overall program offerings in the vo-tech system.

Vocational-Technical Program Implications Resulting From Needs Identification

In general, the vocational-technical school system is doing an admirable job of responding to the advanced technology challenge. The existing program offerings meet most of the current needs of advanced technology firms located in Georgia. However, these programs need strengthening through the addition of new courses, the modernization of training equipment, the hiring of more teachers and the allowance of lighter teaching loads to provide more opportunity for the technical development of teachers.

As advanced technology grows in Georgia new demands for added programs and greater volumes of graduates will change the face of the existing system. The timely response of the system to this challenge will have a significant impact on the continued expansion of advanced technology industries in Georgia.

These implications stress the need for careful planning and a strong committment to meeting the advanced technology challenge. With regard to planning, there must be guidance and support from both the industrial and educational sectors. An intimate knowledge of existing and developing technologies will be necessary to develop responsive recommendations. However, this planning must be supported by a strong committment to meeting the advanced technology challenge.

This will necessitate both the financial and physical support of both the state and industry. The development and maintenance of a strong vocational-technical system benefits industry, the state, and all Georgians.

SECTION IV
An Assessment of the Vocational-Technical System Structure in Georgia and its Impact on Advanced Technology Response

Introduction

National projections for high technology growth are predicting 9.2 million new jobs and a $550 billion increase in sales over the next two decades. The State of Georgia already has a nucleus of electronics and communications industries including Scientific Atlanta, Hewlett-Packard, and Marconi Avionics as well as the Warner Robins Air Force Base which purchased $1.5 billion of high technology products in 1980. In addition, the State has made a commitment to high technology through the ATDC (Advanced Technology Development Center) located at Georgia Tech. We can therefore logically assume that Georgia will be one of several sites considered for locating new technology industries.

But how competitive are we in attracting and retaining such industries? One of the unique features of this high growth industry is its insatiable need for skilled technicians, the type of worker trained by our vocational-technical school system. An in-depth review of this system has shown that despite numerous barriers it is currently producing skilled workers that meet the levels of knowledge required by high tech firms currently located in the State. This is the result of close cooperation between high tech vocational teachers and industry. However, there is a waiting list of students for many programs; qualified teachers are difficult to recruit; and equipment budgets have traditionally taken second place to building and staffing needs.

This section will discuss how other state vocational systems have organized to deal with high technology, where Georgia is now, and where Georgia should be to stay competitive in supporting high technology growth.

An Overview Of Three Systems In Other States

Three states have taken major strides to upgrade their vocational education system in anticipation of the high growth projections in high technology industry.

California

The California education system is governed by four separate boards. The responsibility of K-12 and adult education is under the State Department of Education. The 107 public community colleges are governed by the Board of Governors of the California Community College. The state colleges in California are governed by the Board of Trustees for State Colleges while the university system is governed by the Board of Regents of the University System.

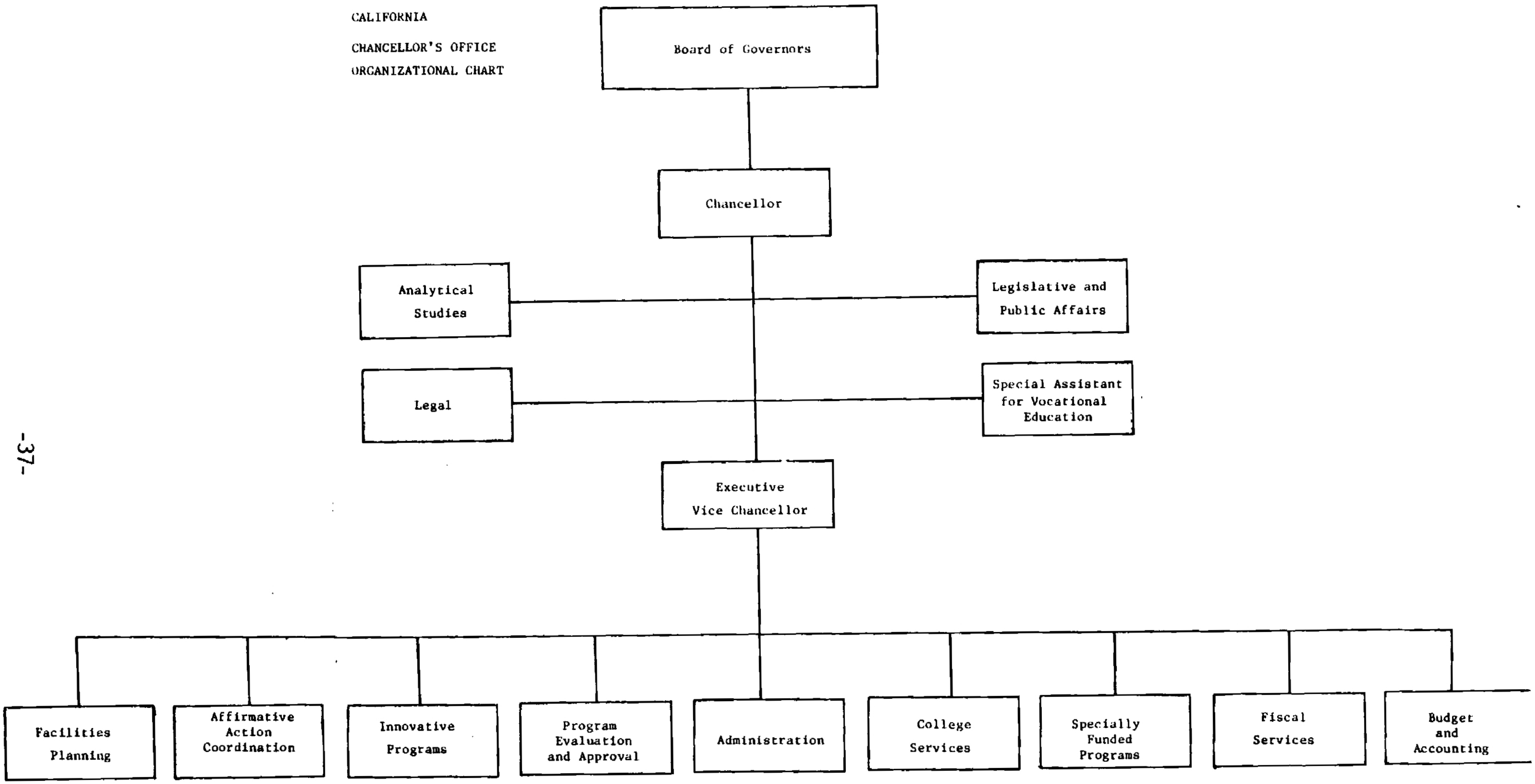
In California, the two year community colleges provide the necessary trained technicians for industry, especially electronics. They offer career development programs, skill improvement, and job retraining as well as a wide range of academic courses. They offer these programs during the day and night at the community colleges as well as at industry locations.

The Board of Governors of the community colleges is a 15 member board, appointed by the Governor. The Chancellor's Office is the working arm of the

CALIFORNIA

CHANCELLOR'S OFFICE

ORGANIZATIONAL CHART



Board of Governors. The primary role of the Board is to supply leadership, coordination, and direction to the locally governed community colleges operating in 70 college districts.

The Chancellor's Office and the Board of Governors of the community colleges was created in 1968. Until this time the community colleges were administered under the Department of Education. The Board of Governors works with an annual support budget of approximately $4.5 million. About half or $2.5 million is provided from the general fund. Funding for the community colleges comes from local funds (20%) and state funds (80%).

The Silicon Valley of California is an area that has many high technology firms. In this valley there are six community colleges that are mandated to respond to local market needs. To help the community colleges in this effort the state has provided financial incentives which moves them to structure courses to fit industries' needs.

An example of this financial incentive is the California Worksite Education and Training Act (CWETA) passed in 1979. CWETA was passed by the legislature in response to the electronics leaders in the state who believed that the community colleges were not meeting the needs of their industry. This act requires the Division of Apprenticeship Standards, the Employment Development Department, the community colleges, and the State Department of Education to work together in providing the funding, technical assistance, and classroom instruction that employers need. This bill was for $25 million financed from the general fund to provide approved entry level and upgrading training programs. Working in a partnership arrangement, employers will identify the skills needed for entry level employment while the community colleges develop the training program to meet these needs. A key part of this act is the upgrading of existing skills of workers. When people are upgrading skills they move to higher levels within the company, leaving entry level jobs for youth and the economically disadvantaged.

Under the act allowable expenses are reimbursable for companies that participate in the upgrading skills training. Companies can be reimbursed for the cost incurred for training supervison, for the maintenance of training records, and other administrative expenses as well as for the additional cost of lost production time.

In recent research efforts by Dr. Elizabeth Useem on the Silicon Valley, CWETA was found to have its problems. People interviewed in this research effort said CWETA was too little too late. The administration of the program was criticized as well as the bureaucratic red tape that was required. In the research done by Dr. Useem there was one exception to this reaction. The College of San Mateo appears to have achieved the goals set for the $2.5 million CWETA electronics program.

In the Silicon Valley there are many relationships between industry and the community colleges. Some examples of these relationships are employer advisory councils, hiring consultants from industry to develop curriculum, equipment donations, cooperative or work experience programs, and schools using industry facilities and equipment for training purposes.

One significant link between industry and education is the use of part-time teachers from industry. One engineering and technology department employs 90 to 120 part-time teachers from high technology firms. These part-time industrial personnel present problems in massive temporary hiring, difficulty in evaluating performance, and lack of a regular faculty to develop curriculum. One of the advantages of using these people is the up-to-date knowledge that they bring to the school.

Although the community colleges in Silicon Valley have programs relevant to high technology industries, they cannot supply the personnel demands of the companies because of financial constraints of the community colleges.

In telephone interviews obtained by the research team and stated in Dr. Useem's research report, the Silicon Valley community colleges are faced with a variety of problems. One example is the rapid change that the electronics industry goes through. Because of this rapid change it is felt that keeping state-of-the-art equipment in the schools will be difficult. Some programs like computer-assisted drafting and vacuum technology will have to utilize the equipment at industrial locations. Other problems that California faces are teacher updating and equipment budget cuts.

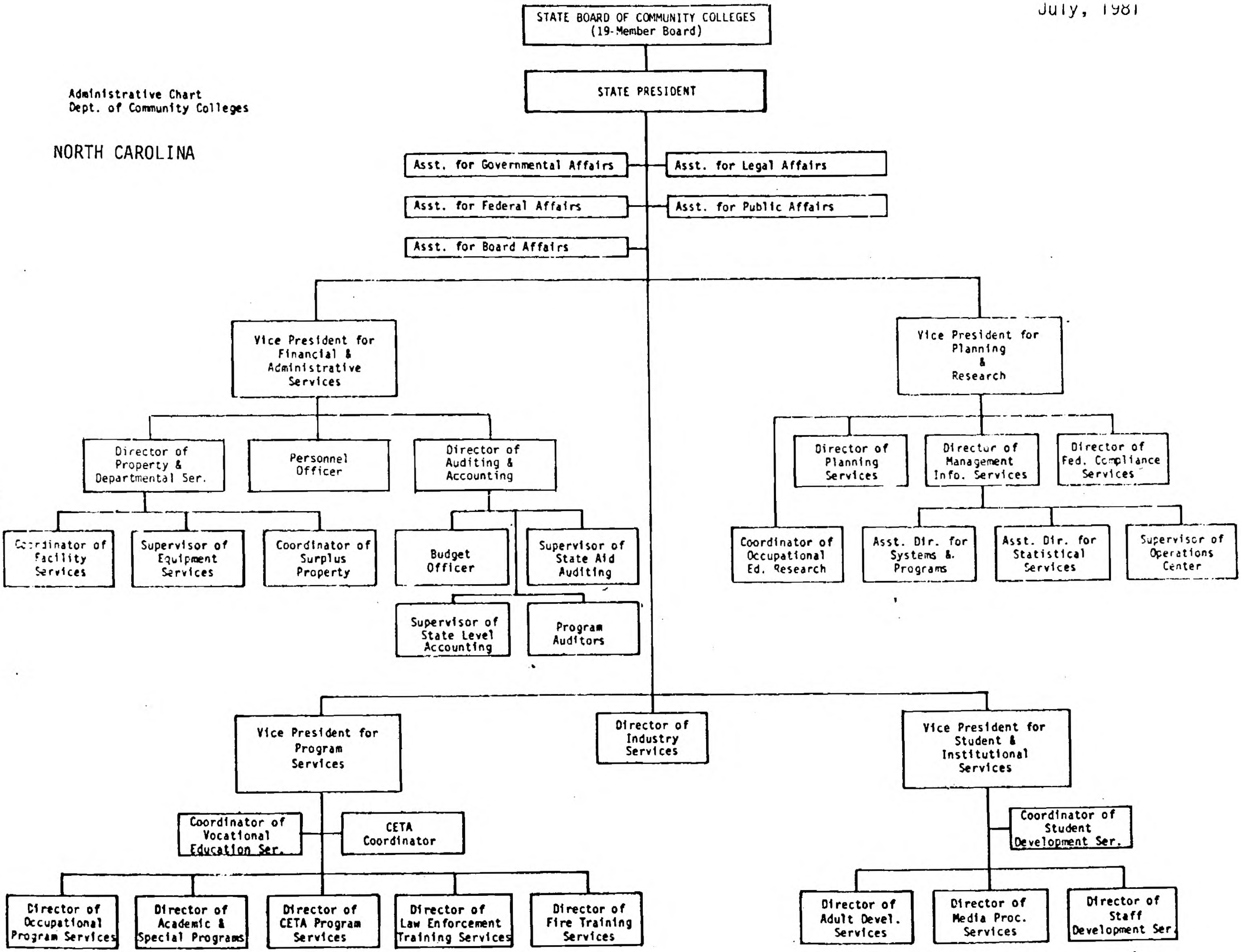
North Carolina

The governance responsibilities for education in North Carolina are divided among three separate governing boards. The Board of Governor's University System is responsible for higher learning. The State Board for Community Colleges, created this year is responsible for the community college system. The administration of the community college system is provided by the Department of Community Colleges which is under the direction of the State

July, 1981

Administrative Chart
Dept. of Community Colleges

NORTH CAROLINA



Board of Community Colleges. This board is appointed by the Governor and has the authority to adopt and administer all policies, regulations, and standards for the community colleges. In turn, each community college is administered by local boards of trustees. The third governing board in North Carolina is the State Board of Education which is responsible for K-12 programs. Up until this year all vocational programs on the secondary and post-secondary level were governed by the State Board of Education.

The community colleges in North Carolina offer programs in seven categories: technical programs, vocational programs, continuing education programs, basic adult education programs, college transfer programs, general education programs, and industry services training programs. The community colleges have served the traditional industries in North Carolina through these programs. In the near future they plan to serve other industries such as microelectronics, genetic engineering, and robot manufacturing.

The Department of Community Colleges has requested prefunding of 30 critical need programs for their 1981-1983 biennium. This request was for $2,211,010 per year for each year of the biennium. The high cost, critical need programs recognized by the Department of Community Colleges are: electronic engineering technology, machinist, industrial maintenance technology, instrumentation technology, industrial and maintenance-electromechanical, associate degree nursing, and electronic data processing-business. Also requested by the Department of Community Colleges was funding for fifteen cooperative skills training centers which will respond to the particular needs of industry. These skills training centers will include a program in the following occupations: tool and die making, machinist, and industrial maintenance. This request was for $1,800,000.

North Carolina has recently put a lot of effort in trying to attract microelectronics companies and related industries to the state. In this effort the Governor has provided approximately $30 million for a microelectronics center to be built at the Research Triangle Park. The Center will initially cost $24.4 million in state appropriations. During the first two years an additional $6 million will be raised through federal sources, foundations, and industry support. The justification for this center rests in the fact that the microelectronics industry and support industries are outgrowing the Silicon Valley area in California. Without this center, Governor Hunt is convinced that this industry will go elsewhere. One of the main purposes of the Center is to attract and train individuals in microelectronics and to create the academic environment needed to attract this industry and its support industries to North Carolina.

The proposed Center has already paid off for the State of North Carolina. In August 1980; General Electric Company announced the building of a $50 million microelectronics center at the Research Triangle Park. The GE Center will engage in research, development, production, training, and education needed by General Electric. Their Vice Chairman, Edward Hoot, said, "A key factor in the selection of North Carolina was its new microelectronics program with a state center in the Raleigh-Durham area."

The effect that this center will have on the community colleges has not been determined. The community college system will be working closely with the center to provide technicians with the kind of technical training needed in the microelectronics and support industries.

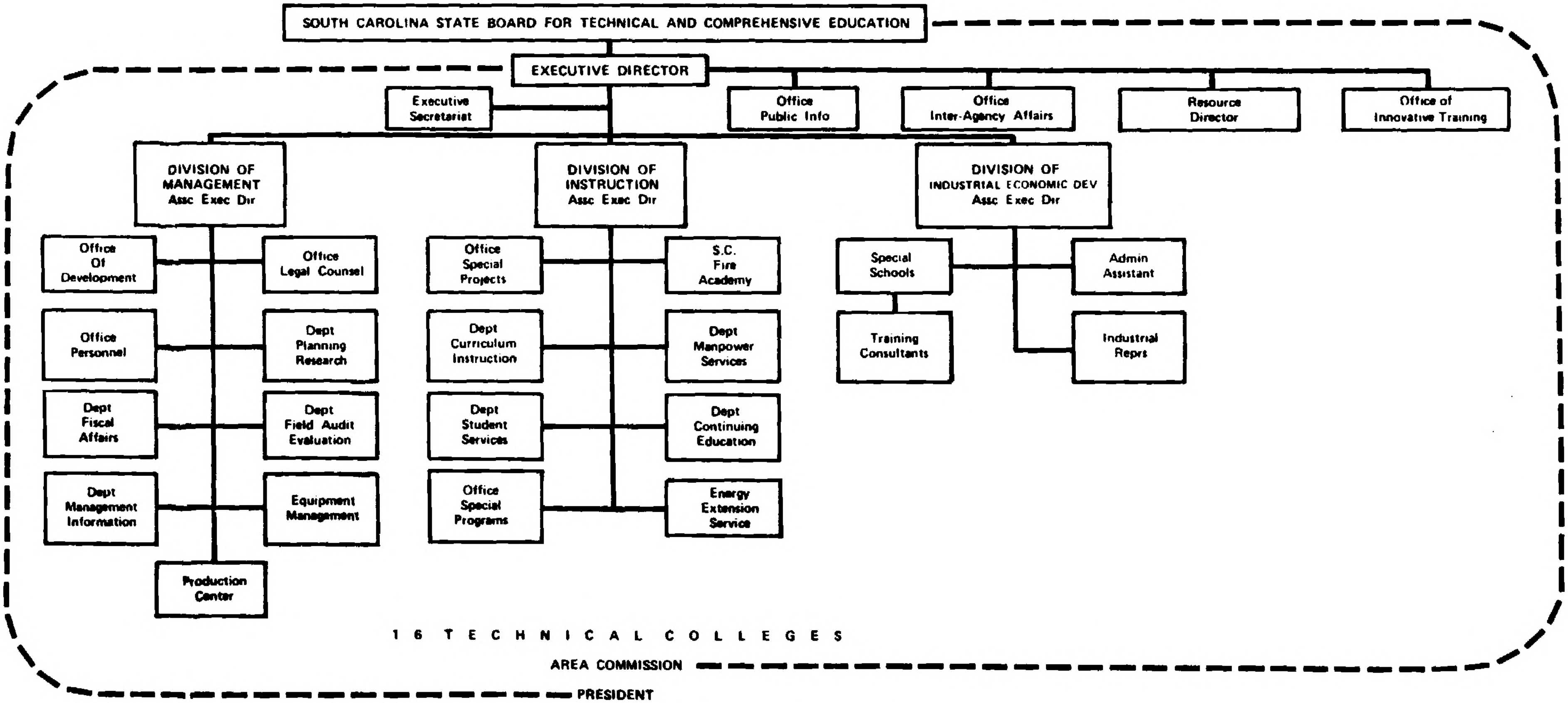
One of the main problems in meeting the needs of high technology firms at the community college level is acquiring and maintaining equipment. This has been set as a first priority in North Carolina. Other needs of the community colleges in order of importance are: teachers' salaries, working closer with industry for upgrading teachers, and new high tech curriculum.

South Carolina

The governance of education in South Carolina is divided between three governing boards. The Commission of Higher Education is responsible for strengthening all the State's institutions of higher learning. The Commission is a coordinating body with its main function being planning.

The State Board for Comprehensive and Technical Education is responsible for all state-supported technical institutions. The State Board has authority over all post-secondary diploma and associate degree programs dealing with vocational-technical and occupational areas which are financed in whole or part by State funds. The State Board for Comprehensive and Technical Education is a coordinating board with financial accountability. Programs are offered through their eighteen technical colleges on a full or part time basis.

The South Carolina State Board of Education has responsibility for secondary educational programs and adult vocational programs.



SOUTH CAROLINA STATE BOARD FOR TECHNICAL AND COMPREHENSIVE EDUCATION
EXECUTIVE DIRECTOR
Executive Secretariat
Office Public Info
Office Inter-Agency Affairs
Resource Director
Office of Innovative Training
DIVISION OF MANAGEMENT Assc Exec Dir
DIVISION OF INSTRUCTION Assc Exec Dir
DIVISION OF INDUSTRIAL ECONOMIC DEV Assc Exec Dir
Office Of Development
Office Legal Counsel
Office Personnel
Dept Planning Research
Dept Fiscal Affairs
Dept Field Audit Evaluation
Dept Management Information
Equipment Management
Production Center
Office Special Projects
S.C. Fire Academy
Dept Curriculum Instruction
Dept Manpower Services
Dept Student Services
Dept Continuing Education
Office Special Programs
Energy Extension Service
Special Schools
Admin Assistant
Training Consultants
Industrial Reprs
16 TECHNICAL COLLEGES
AREA COMMISSION
PRESIDENT

High technology jobs requiring fewer people pose a challenge to the traditional concept of job training in the technical schools. An industry may need only a few highly skilled individuals in their entire work force. Because of this, South Carolina has decided to approach these technologies in a more bold, innovative manner. Their program involves all elements of the current technical system -- technical education, industrial training, and upgrading/retraining programs for those already employed -- with added flexibility and creativity.

Their program is a planning procedure with some specific recommendations that will meet the educational needs of the future in the areas of relevant curricula -- special schools for industries, continuing education, and cooperative education programs.

In 1979, their "Design for the Eighties" concept was adopted with a budget allocation of $317,000 for fiscal year 1980. This concept established five resource centers in existing technical schools throughout South Carolina:

1. Computer Applications
2. Electronics
3. Robotics
4. Future Office Occupations
5. Advanced Machine Tool Technology

The State Board for Technical and Comprehensive Education last year created the position of Coordinator of Innovative Technical Training to spearhead their efforts past FY 1980. The coordinator looks for the most effective and efficient ways of changing curriculum, upgrading teachers, and getting new equipment.

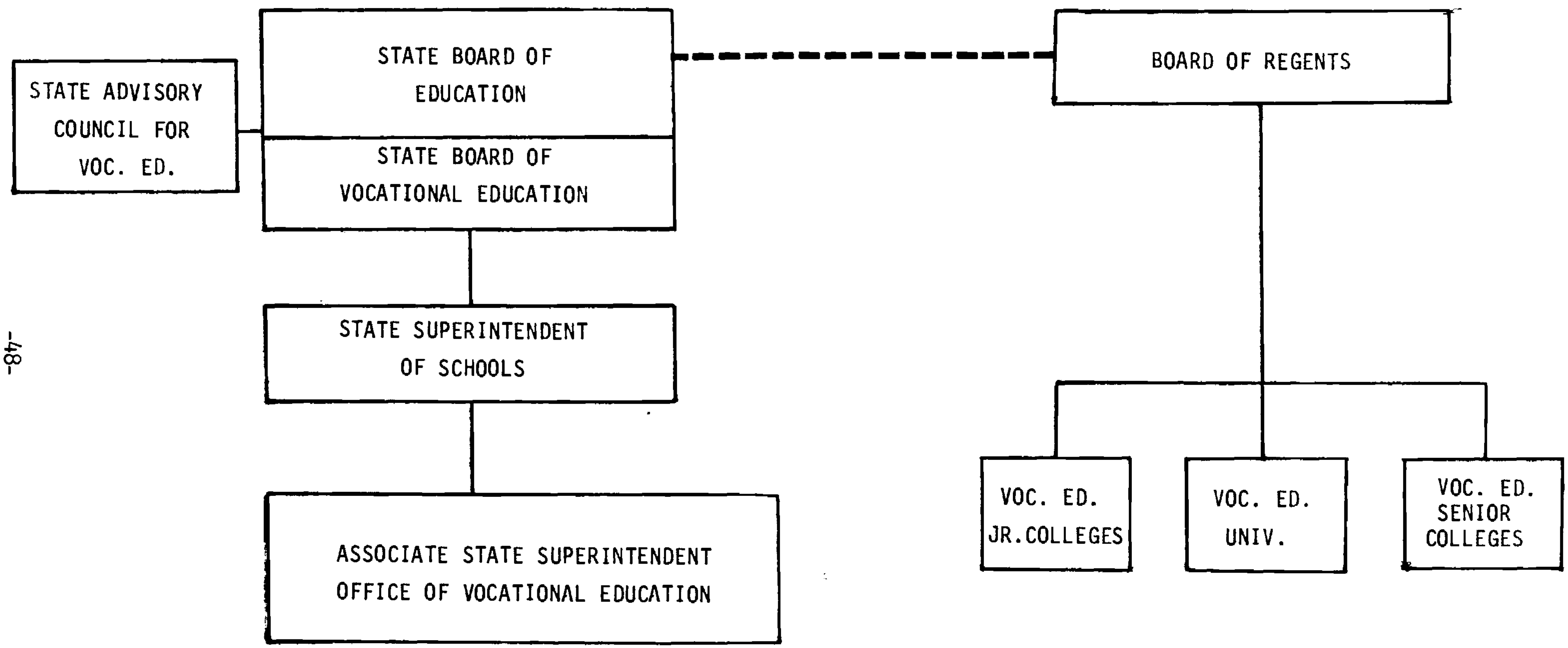
One of the biggest barriers to implementing these programs is equipment. South Carolina has gotten equipment donations, but it has not been enough. They requested and received in two phases a total of $1,750,000 for equipment purchase. This money came from bonds and has been held up by the budget control board.

Georgia's Current Structure

The governance and regulatory responsibilities for vocational education are divided among several authorities and are at different levels. At the state level, vocational education is divided between the State Board of Education and the Board of Regents. At the local level, vocational education is divided between these two boards as well as city or county boards and area boards of education.

The State Board of Education has responsibility (both constitutionally and statutorily) with general supervision of K-12 education as well as all vocational programs in the secondary and post-secondary schools. Members of the Board of Education are appointed by the Governor and, by law, the elected State Superintendent is the executive officer of the State Board of Education for vocational education.

The Board of Regents has responsibility (both constitutionally and statutorily) with supervision of higher education. Their responsibility includes vocational programs in junior colleges, senior colleges, and universities.



ORGANIZATION CHART FOR VOCATIONAL SYSTEM

GEORGIA

We deliver vocational programs and training at the post-secondary level by many methods. Programs are offered through area vocational-technical schools, joint programs with junior colleges, residential vocational-technical schools, and vocational centers. Some programs are offered at high schools as well as at industry-owned facilities.

Post-secondary education in Georgia is funded by federal, state, and local funds. The majority of funding for education in Georgia is supplied by state funds.

As part of the analysis of the Georgia vocational system, a survey of area school directors was made to determine perceived barriers to the implementation of high technology programs. Thirty schools were sent surveys and twenty-eight responded. A summary of results is shown in Figure 1.

Each of these barriers is discussed in detail below.

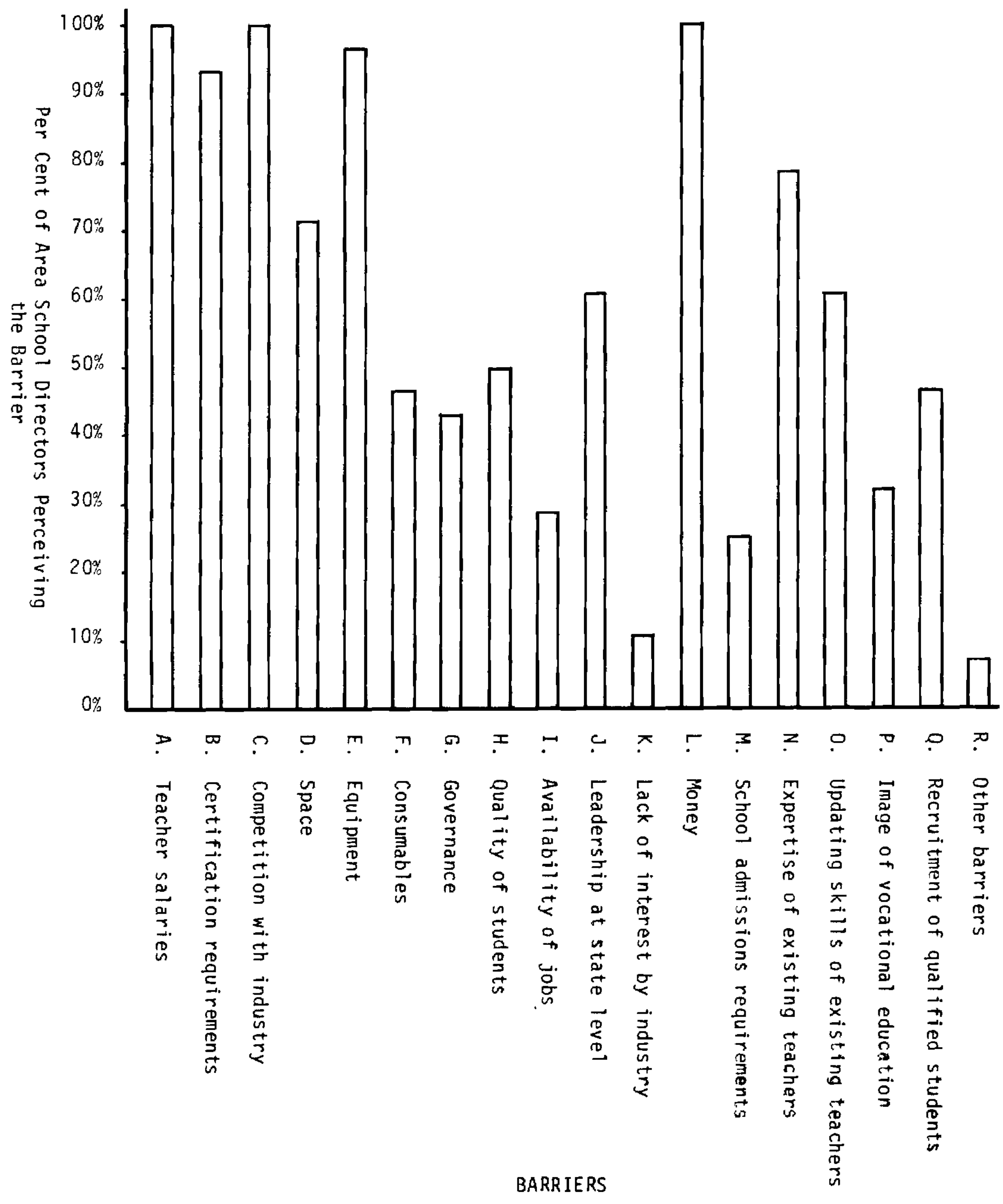
A. Low Teacher Salaries

All twenty-eight school directors responding to the questionnaire stated that teacher salary limitations were a problem in the implementation of high technology programs.

Effective September 1, 1981, the starting monthly salary for a post-secondary teacher with a V-4 certificate is $1265.00. If this teacher is a qualified occupational teacher with appropriate work experience, he may be moved up as many as three steps on the vocational pay schedule to $1360.00. This work experience must be beyond the minimum required by the State Department for initial certification.

FIGURE 1

BARRIERS PERCEIVED BY AREA SCHOOL DIRECTORS



For a qualified technician to leave industry and teach, he or she must take a 20% to 40% reduction in pay. Since there is a national shortage for qualified technicians, industry has been and still is willing to pay these technicians to stay in industry.

At present, teachers in the post-secondary schools do not get credit for military service on the salary schedule, while secondary teachers are given credit.

All post-secondary directors have expressed concern in their Fall 1980 position paper, and in a January 1981 report of the Vocational-Technical Governance Study Committee of the House Education Committee and the House University System of Georgia Committee that they may not be able to find qualified instructors for the salary Georgia offers.

B. Certification Requirements

Twenty-six of the post-secondary directors felt that certification requirements are a problem in implementing high technology programs in their schools.

The main problem with certification lies in trying to attract new teachers rather than recertifying existing teachers. The school directors did point however to problems in recertification, such as the type courses (education courses) that teachers had to take.

In Georgia new teachers are certified through the competency-based teacher certification program. This program is designed to assess teacher competencies through the administration of a criterion-referenced test and on-site assessment. There are a few exceptions to this program but the majority of new post-secondary teachers must meet this requirement.

There are three components of the competency-based teacher certification program: (1) subject matter testing, (2) on-site assessment of teaching competencies, and (3) successful completion of thirty hours of teacher education within the first three years of employment. When these three components of teacher certification are successfully completed, a teacher will then be given a certificate for a designated time period.

All post-secondary directors have expressed concern in their Fall 1980 position paper and in a January 1981 report of the vocational technical Governance Study Committee of the House Education Committee and the House University System of Georgia Committee that they may not be able to find qualified instructors able or willing to meet certifying requirements in Georgia. In a January 1981 report by the Vocational-Technical Governance Study Committee, a recommendation was made to reorganize the certification procedures for the V certificates.

It should be noted that certification itself is probably not the main problem. Competency in technical fields as well as competency in education skills cannot be disputed as requirements for a successful teacher. However, certification in conjunction with low pay scales and a heavy workload makes the prospect of spending one's own time taking required education courses with no emphasis on keeping up-to-date within the technical field extremely questionable.

C. Competition With Industry For Qualified Personnel

All twenty-eight of the post-secondary school directors felt this was a problem in the implementation of high technology programs.

Industry and post-secondary education will continue to compete for the same qualified personnel. It is evident that industry has been willing and able to do what is necessary to attract and keep the qualified personnel in their companies. Without the qualified personnel to teach the high technology programs, education will continue to pay "catch-up" in high technology training.

In a recent study done on the Silicon Valley of California this problem was reported. In the Silicon Valley many community college departments rely heavily on part-time teachers from industry. This is necessary due to the lack of qualified applicants for full-time positions in technical departments. For example, an Engineering and Technology Division of one college employs 90 to 120 part-time teachers and only 10 full-time teachers.

In the past it has been difficult to employ competent personnel who are qualified to teach programs that meet the needs of industry. The area vocational-technical schools have employed teachers with minimal qualifications, experience, and education. Many of the general advisory and craft advisory committees have been concerned by the quality of instruction given in some programs. Quality instruction requires qualified teachers.

D. Space (Facilities)

Twenty-one of the post-secondary directors said space was a problem in implementing high technology programs. In follow-up school visits, it was found to be a problem in many of the older post-secondary schools. For example, it was reported in a December 1979 report of the Joint Vocational-Technical Education Study Committee that Dekalb Vocational-Technical School was currently operating at or near capacity in many course offerings. When the research team visited Dekalb Vocational-Technical School we still found this to be true.

Many high technology courses have long waiting lists of students, with little room or money to expand existing facilities. The Zimmerman study has provided a plan to systematically expand existing facilities; however, it appears to be inflexible. There is also no incentive for school directors to phase out programs for which little or no need exists.

E. Equipment

All twenty-eight of the post-secondary school directors stated that equipment would be a problem in implementing high technology programs in their schools.

Since the founding of area vocational-technical schools this has been a problem. The vocational system philosophy has been to provide training within a 50-mile radius to all students who apply. The growth of schools has left limited funds for updating equipment. The equipment replacement budget was $2.5 million in Fiscal Year 1979 and has remained at that level through Fiscal Year 1982.

This situation has not changed mainly because the state is in need of additional schools, along with expansion of the existing schools. At present, equipment is wearing out as well as becoming outdated and useless for training purposes.

The January 1981 report of the Vocational-Technical Governance Study Committee of the House Education Committee and the House University System of Georgia Committee found that the majority of the equipment in the post-secondary schools was satisfactory. However, the criteria used to determine the condition of the equipment is not clear. In the area of high technology where technological changes take place at a very rapid pace, an outdated piece of equipment may be utterly useless despite its being in good working order. The two concerns of the governance study committee were of keeping up with industry and the procedure of purchasing equipment. In their recommendations they suggested a systematic approach to buying and replacing equipment.

In a research study done on the Silicon Valley area in California, equipment was also a problem. All of the community college people interviewed said it was difficult to keep state-of-the-art equipment in their schools. Some programs will have to depend on on-site training so the equipment of the companies can be used. Examples of these programs are computer-assisted drafting, microwave technology, and vacuum technology. Companies in the Silicon Valley have donated state-of-the-art equipment, but they have not been able to meet all the schools' needs.

F. Consumables

Eleven of the post-secondary school directors saw consumables as a problem in implementing high technology programs in their schools.

G. Governance

Eleven post-secondary school directors stated that governance would be a problem in implementing high technology programs in their schools. This represents 42.9% of the vocational school directors. 14.3% of these answers came from directors governed by area school boards and 25% came from directors governed by local boards of education.

The governance of vocational education is a recurring issue. In the joint vocational-technical education study committee report of December 1978 it was stated that the overall governance, especially of post-secondary education, is divided unequally among many authorities. There is no single agency which has primary coordinating authority for all components of vocational education, especially the post-secondary component.

The governance issue was also cited as a potential problem by the Georgia Educational Improvement Council in their December 1978 report. This report suggested many discussion models and an overview of current coordinating efforts for the governance and coordination of vocational educational and manpower development.

In January 1981, the Vocational-Technical Governance Study Committee of the House Education Committee and the House University System of Georgia

Committee made a recommendation on the governance of post-secondary in Georgia. They recommended that the State Board of Education create the position of Associate State Superintendent of Post-Secondary Vocational Education. This is a similar position taken by the Georgia Area School Directors' Association in their position paper in the fall of 1980.

H. Quality of Students

Fourteen of the post-secondary school directors said that quality of students is a problem in implementing high technology programs in their schools.

There is a national decline in academic achievements in our schools. In mathematics and science education there is increasing awareness that a crisis is developing. Without strong math or science backgrounds it will be difficult for students to graduate at a fast rate for the high technology industries. Remedial courses have been instituted at the vocational schools, and each student is counselled before entering the field of their choice.

I. Availability of Jobs

Only six of the post-secondary school directors said that availability of jobs is a problem in implementing high technology programs in their schools. Within the vocational system there are some safeguards against educating students without potentially placing them on the job. Each school must do a needs analysis before a new program can be put in place; teachers keep apprised of job opportunities within industry and guide their students accordingly.

J. Leadership At State Level

Sixteen of the post-secondary school directors said that leadership at the state level was a problem in implementing high technology programs in their schools.

In a Fall 1980 position paper of the Georgia Area School Directors' Association this was a major concern. The area school directors asked for strong leadership at the state level operating with sufficient independence.

Currently there is no mechanism for defining and directing the technical path that schools should be taking to meet the future needs of high technology industry. Also, post-secondary vocational-technical schools are in limbo somewhere between secondary vocational education and all post-secondary education including junior and senior colleges, with no well-defined position of their own. Hence, they are often overlooked.

K. Lack Of Interest By Industry

Only three of the post-secondary school directors said that lack of interest by industry was a problem in implementing high technology programs in their schools.

In follow-up personal interviews with eight of the post-secondary school directors and teachers, they said that it is important for industry to participate the high technology programs. We do have cooperative programs in our state that are successful. Warner Robins Air Force Base has an agreement with the Houston Vocational Center to train electronic mechanics. More than 125 students are on the waiting list for this program, and graduates receive an average annual salary of $20,000. Augusta Area Vocational-Technical School has a cooperative program with Columbia Nitrogen in Industrial Maintenance. Students successfully completing the full eight-quarter sequence are guaranteed a job at a starting salary of $30,000.

M. School Admissions Requirements

Six of the post-secondary school directors see school admissions requirements as a problem in implementing high technology programs in their schools. At this time the post-secondary schools have an open-door policy to their vocational programs. A Career Planning Profile is being field-tested to determine its validity as an admissions requirement as well as a counselling guideline.

N. Expertise Of Existing Teachers

Twenty-two of the post-secondary school directors see level of expertise of existing teachers as a problem in implementing high technology programs in their schools.

In telephone interviews to South Carolina with personnel associated with the vo-tech system, they also saw this as a problem. Before high technology courses can be offered they must have the qualified teachers to teach them. One of the main objectives of the resource centers in South Carolina is for training teachers and upgrading skills. They have also spent time and money in allowing teachers to attend seminars pertaining to the new area they will be teaching.

With the rapid rate of change of high technology, this will continue to be a problem.

O. Updating Skills Of Existing Teachers

Seventeen of the post-secondary directors said this was a problem in implementing high technology programs in their schools.

In the State of Georgia there are many ways an existing teacher can update his or her skills. This can be done by taking education courses, by participating in Project Update, in-service conferences, and by staff development courses given by the local educational institute. Release time for teachers to upgrade their skills is limited to 48 days in a three-year period subject to approval by the area school director. State funds do not provide for a substitute's salary.

In South Carolina they have gone to the TIPS program for updating of skills. TIPS is a program funded by grants from the Appalachian Regional Council and Strengthening Developing Institutions Program. The main objective of these grants is for curriculum development and faculty/staff development. At Greenville TEC, the grant is a project that gives the teacher time off for curriculum and personal development activities with a paid substitute.

P. Image Of Vocational Education

Nine of the vocational school directors see the image of vocational education as a problem in implementing high technology programs in their schools.

Vocational education has had a historical image of a dumping ground for students who could not cut it in academic education. This image is changing with the increased number of people following some field of vocational training and with higher salaries being offered by high technology industries.

Q. Recruitment Of Qualified Students

Thirteen of the post-secondary school directors see this as a problem in implementing high technology programs.

Vocational education has traditionally been viewed by higher education and parents alike as "trade schools," one step below colleges, attracting drop-outs and incorrigibles who cannot make it at institutions of higher learning. However, high technology industry with its heavy demand for skilled technicians who can troubleshoot complex equipment and its ability to pay high salaries can change these attitudes. Also, the electronics revolution will eventually increase the degree of sophistication in many traditional areas such as auto mechanics, machine shop, and appliance repair.

Georgia As It Should Be

During our survey of directors, we asked them not only what the barriers were to implementation of high technology but also what mechanisms should be instituted to make the vocational system more responsive to future industry's needs. Directors were asked to rate the following aspects of delivery from 1 to 5 where 1 represented "extremely effective" and 5 represented "least effective." When asked where high technology programs should be offered for most effective results, average ratings were as follows:

		Rank
A.	All schools	2.9
B.	Only schools near an industrial region offering high tech employment	2.0
C.	Specialty center within one existing scholl	3.2
D.	An industrial facility or resource center outside the vo-tech system's existing schools	3.9

When asked how effective the following methods of instruction would be for high technology courses, average ranking was as follows:

		Rank
A.	Mobile classroom/Lab	4.3
B.	Videotape	4.0
C.	On-the-job training at industrial sites	1.8
D.	Computer-aided instruction or simulation	3.0

When asked about the effectiveness of co-operative teaching ventures between traditional vo-tech instructors and the following types of personnel, average ranking of the choices was as follows:

		Rank
A.	Industry personnel	1.6
B.	Training consultants	2.7
C.	University faculty and staff	3.4

Based on the directors' replies, the most favored delivery system is very similar to the current method. That is, schools should offer programs most suited to industry within the community with close contact between vo-tech teachers and industries that employ the school's graduates with some on-the-job training.

The present level of co-operation between high technology teachers and industry has provided good results to date. However, lead time can vary from one to two years; so a large influx of high technology industries could quickly overload the vo-tech system if steps are not taken to anticipate higher level requirements. Also, since other states have already instituted specific programs geared to attracting high technology industry, Georgia may quickly take second, third, or fourth place as a possible location for new business.

On-the-job training is a typical first choice for a system that trains skilled personnel for placement within the community. Several teachers have implemented an on-the-job training program integrated with their curriculum. Although computer-aided instruction and videotape courses were ranked low by the directors, it is felt by the research team that the nature of high technology topics would lend itself well to these methods of instruction and could provide a lower cost alternative to upgrading all programs in all schools. Teachers expressed reluctance to use audiovisual programs exclusively because a good proportion of their students respond more quickly to personal guidance rather than self-study. However, the traditional videotape consists of a dry classroom lecture with shots either of a speaker or a set of notes. Professionally produced videotapes would improve the effectiveness of this medium.

Using industry personnel as teachers can be an effective method of teaching students the latest methods and equipment in their field. Some vo-tech teachers already use guest speakers and field trips to augment their curriculum. Also, there are a few successful co-op ventures and intern programs in the state. California actually hires part-time instructors from industry. At this time, there is no mechanism within the vo-tech system to do this. It could, however, provide a solution to the shortage of qualified teachers.

Directors were also asked what changes they would make to upgrade their programs to state-of-the-art. Results are shown in Figures 2-6. From these results it is obvious that strengthening curriculum, updating equipment, and updating teacher skills must be made high priority items if the vo-tech system is to remain competitive with other states.

Percent of Area Vo-Tech Directors Requiring
A Given Change to Update Their DATA PROCESSING
Programs to State-of-the-Art
Based on 28 Programs

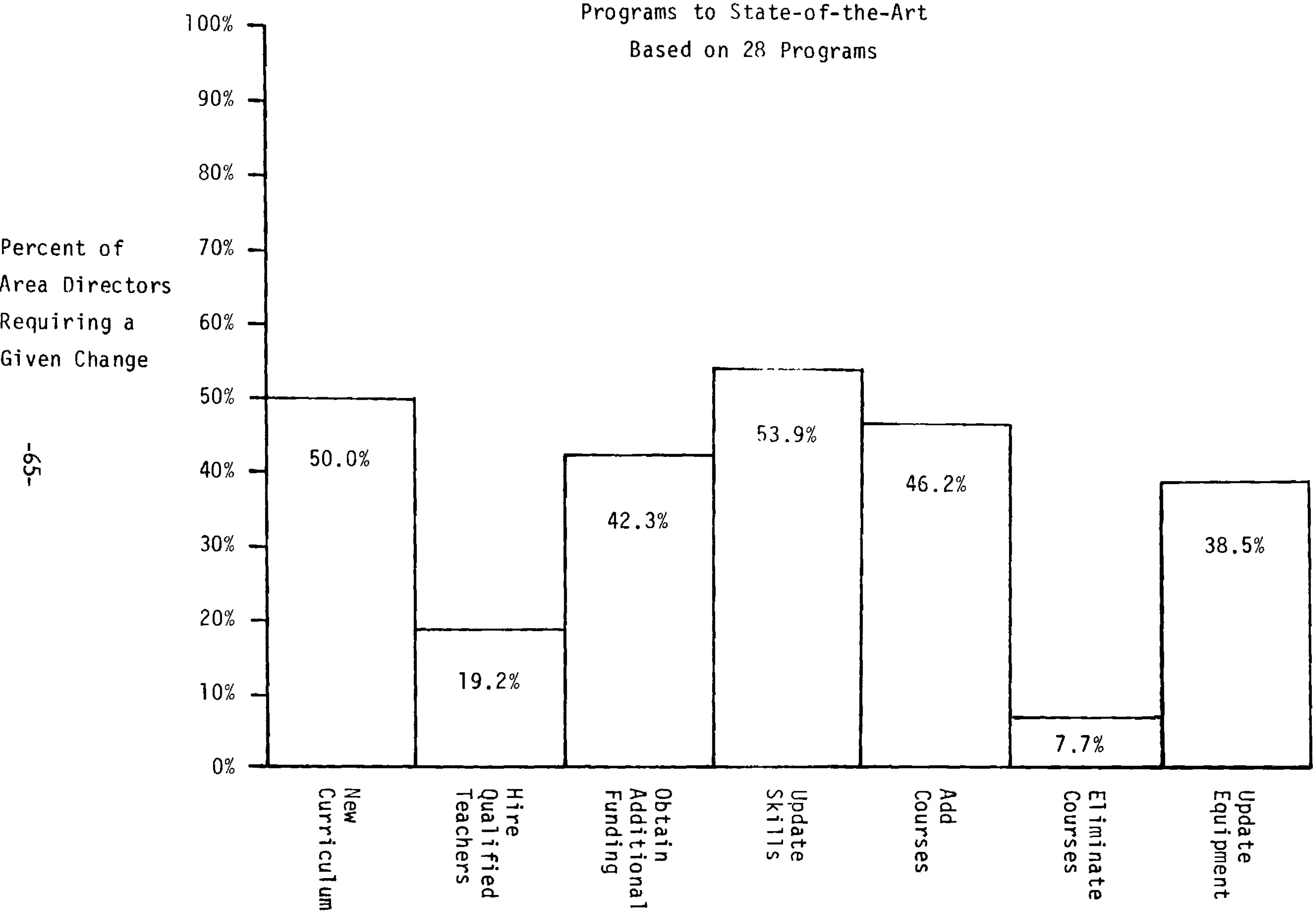


Figure 2

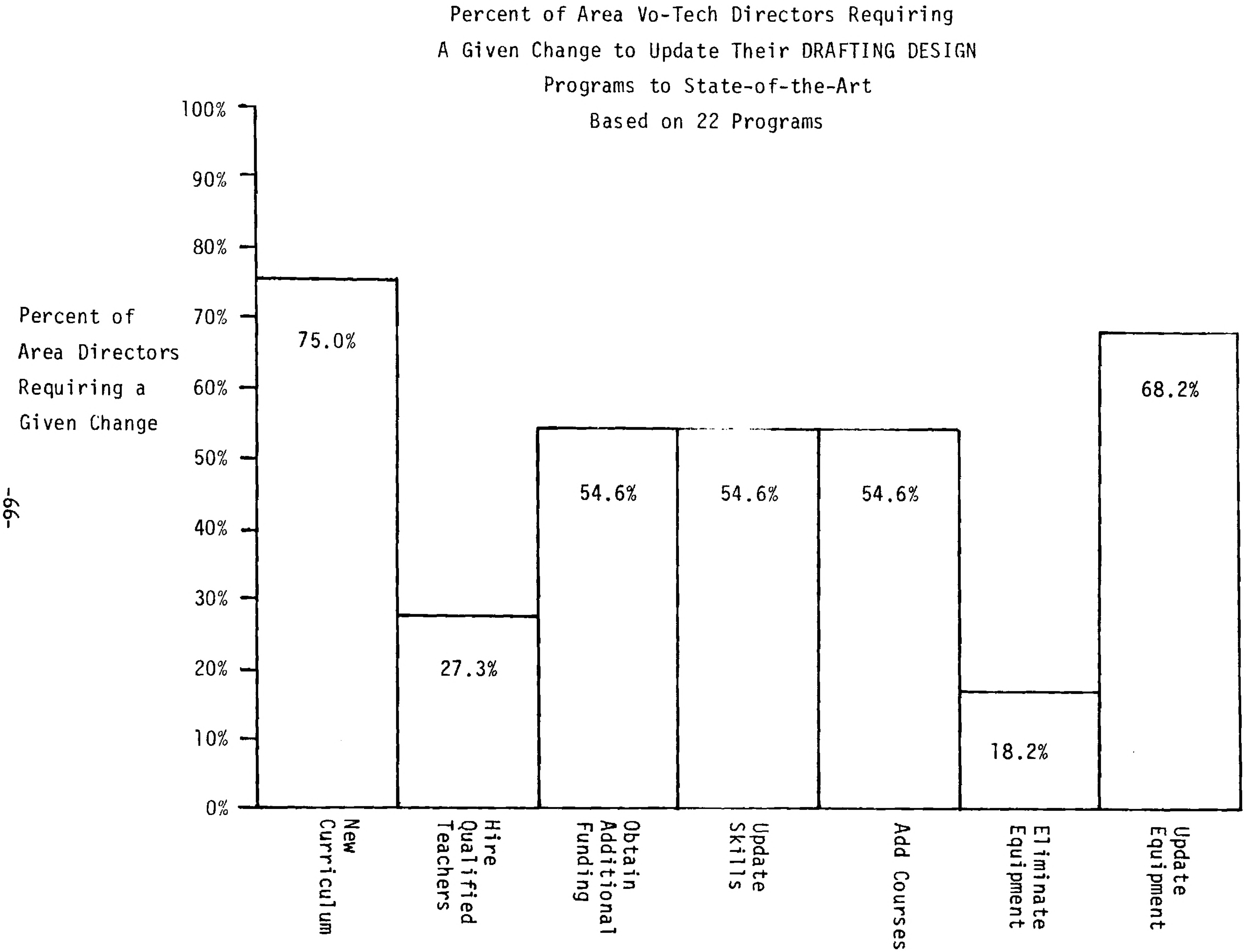

Percent of Area Vo-Tech Directors Requiring
A Given Change to Update Their DRAFTING DESIGN
Programs to State-of-the-Art
Based on 22 Programs
Percent of Area Directors Requiring a Given Change
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
75.0%
27.3%
54.6%
54.6%
54.6%
18.2%
68.2%
New Curriculum
Hire Qualified Teachers
Obtain Additional Funding
Update Skills
Add Courses
Eliminate Equipment
Update Equipment

Figure 3

Percent of Area Vo-Tech Directors Requiring
A Given Change to Update Their ELECTRO-MECHANICAL
Programs to State-of-the-Art
Based on 12 Programs

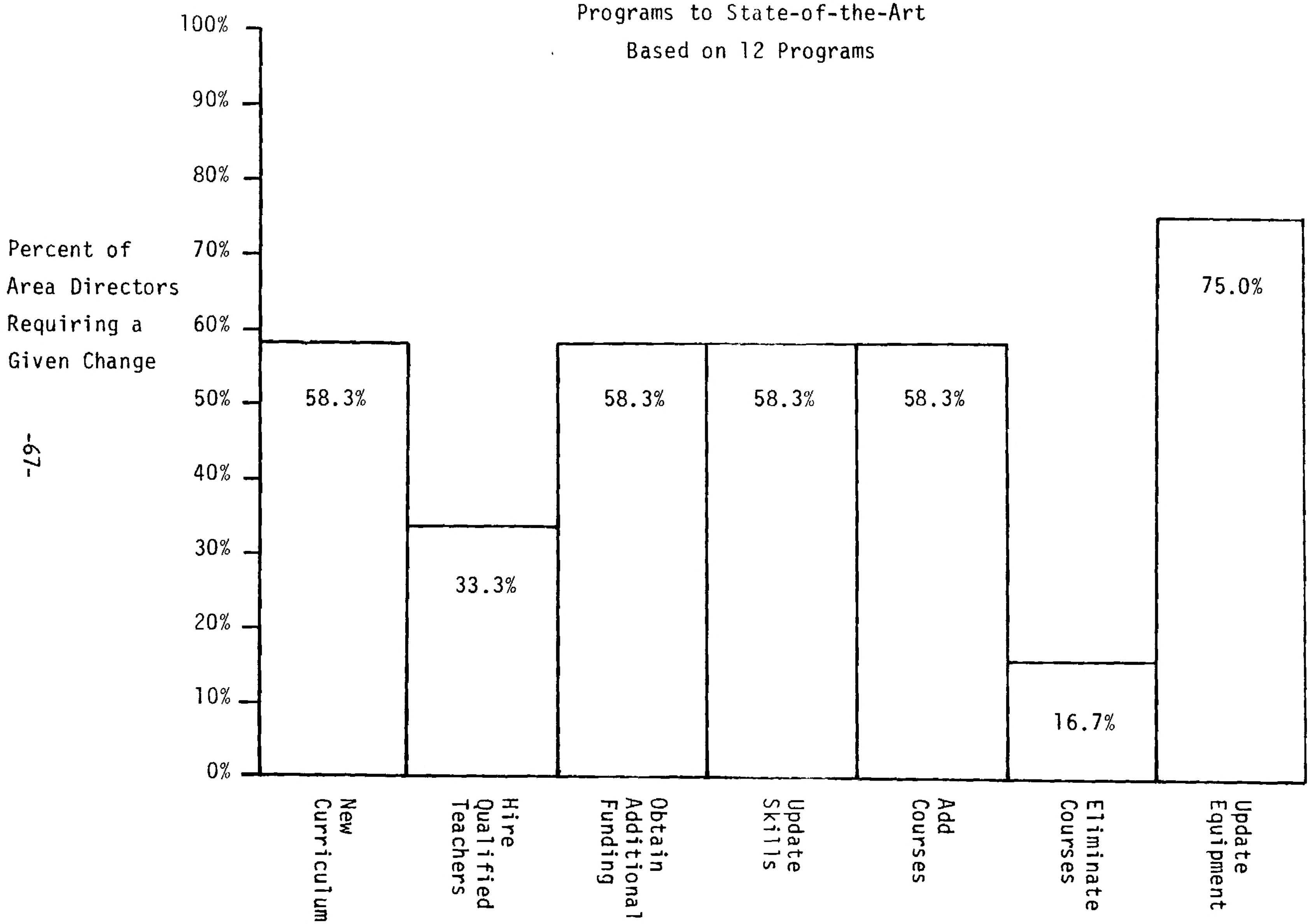


Figure 4

Percent of Area Vo-Tech Directors Requiring
A Given Change to Update Their ELECTRONICS
Programs to State-of-the-Art
Based on 23 Programs

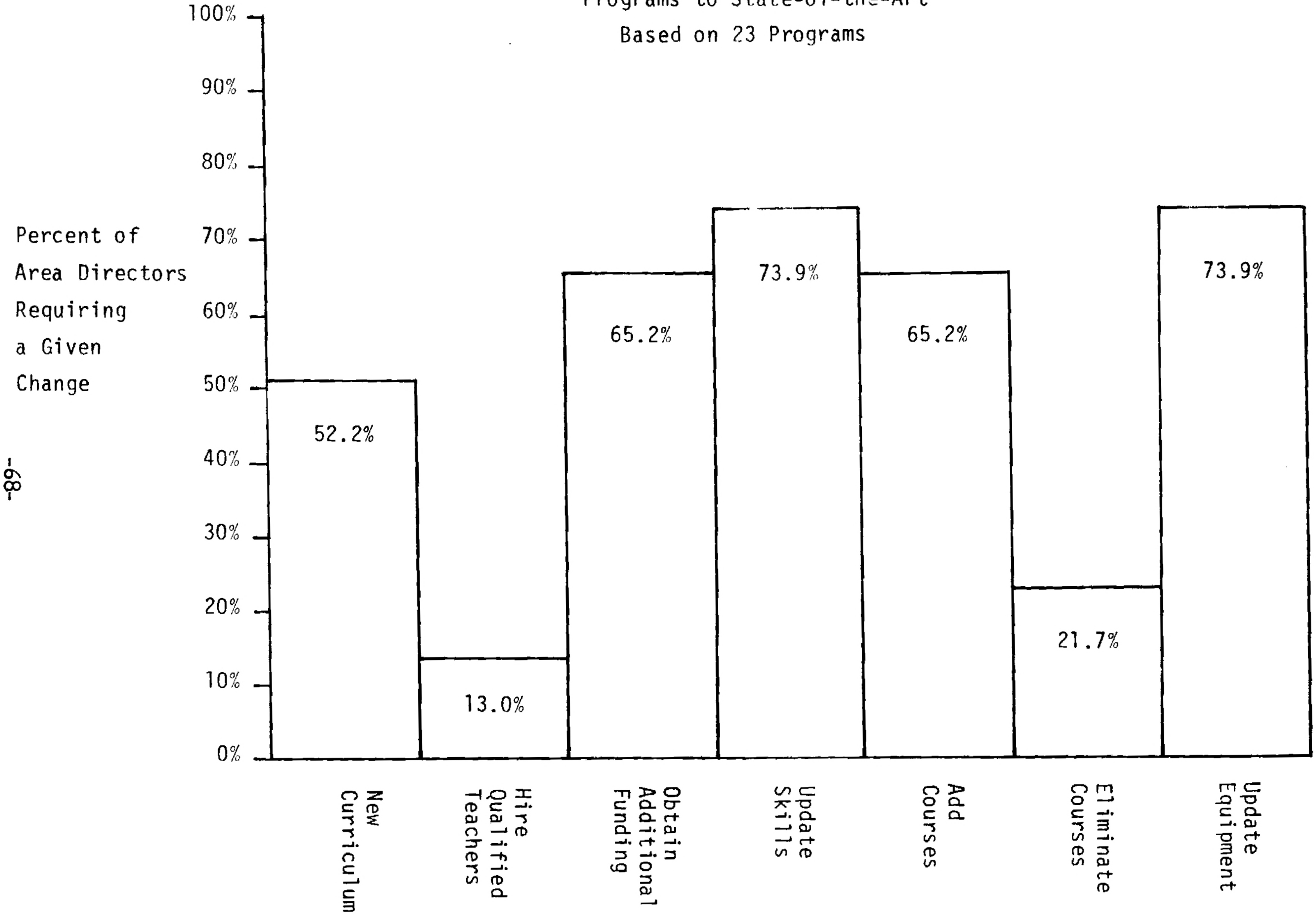


Figure 5

Percent of Area Vo-Tech Directors Requiring
A Given Change to Update Their MECHANICAL
Programs to State-of-the-Art
Based on 10 Programs

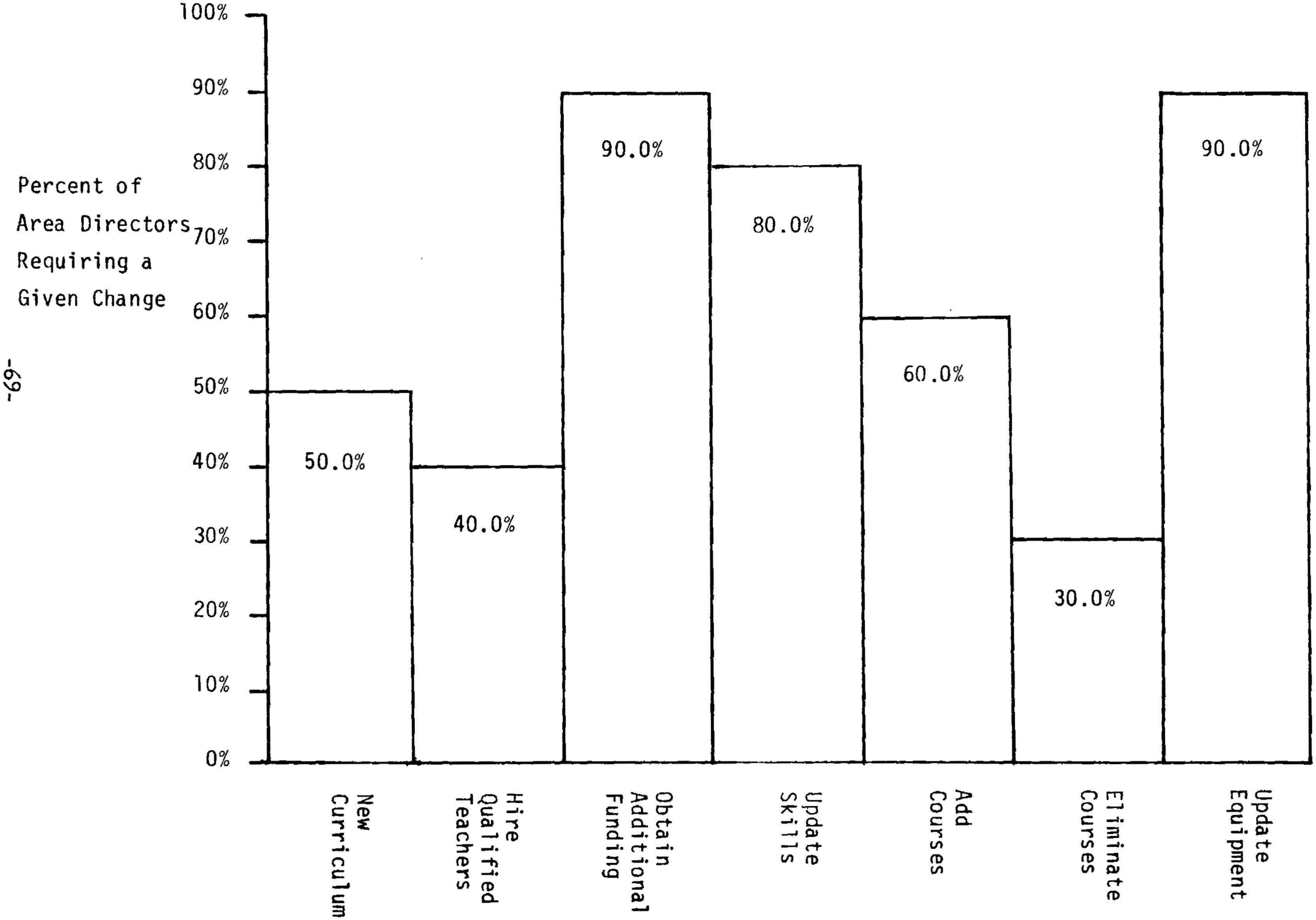


Figure 6

SECTION V
Recommendations

The obvious question that remains after the weaknesses of a system are laid bare is how to strengthen it? In the case of the Vocational-Technical system this decision involves two considerations:

1. In the near term what can be done immediately to correct the more serious problems?

2. In the long term, how should the system adjust to deal with new high technology challenges?

Near Term

We recommend that several areas be addressed immediately in order to provide quick response to the growing demands of high technology. Administrative barriers in the current system hamper its effectiveness in properly reacting to high technology demands once they are presented by industry. Lack of a consolidated guidance and planning function hinders the system's ability to deal specifically with the future needs of high technology. Specific problems and proposed solutions are discussed in detail below.

****

PROBLEM: Equipment for those programs offering the highest employment potential are outdated or non-existent in many schools.

PROPOSED SOLUTION: Upgrade electronic equipment to a basic minimum standard. Develop an equipment sharing program for high cost items.

****

Based entirely on industry and school comments, we see a need to upgrade immediately electronic equipment in the vo-tech schools to bring programs up to current industry standards. This means new items such as digit circuitry signal analyzers and integrated circuit analysis trainers must be purchased and existing items such as mechanical voltmeters replaced with more modern versions such as digital electronic multimeters. These upgradings must occur across the board at all schools because electronics technology impacts all areas of the state (either because of high technology production or high technology usage). We estimate that the average school will need as much as $160,000 to accomplish this basic upgrading. Based on 28 schools this would mean $4,480,000 in immediate equipment funding is called for.

In addition to upgrading basic equipment, we see a need to expand the availability of selected equipment which cannot be provided to each school. We identified a current need for a computer numeric controller. These cost about $350,000 per unit, and students throughout the school system need exposure to it. We propose the development of an equipment sharing program. For instance, if three controllers were purchased and mounted on trailers which allowed their transport around the state, then schedules could be developed which allowed the equipment to be made available at select intervals to every school. The cost of such a program for this badly needed item would be about $1.5 million assuming three controllers were purchased and fitted on an eighteen wheel mobile transporter.

****

PROBLEM: The vo-tech system is able to attract few qualified teachers in rapidly expanding fields because of competition with industry, and those few are given insufficient opportunities to upgrade their technical skills.

PROPOSED SOLUTION: Increase teacher salary ranges to a level commensurate with their marketplace value. Reduce teacher workload to allow for periodic leaves of absence to work in industry and attend technical training sessions. Utilize industry personnel as guest instructors.

****

There is a critical shortage of qualified teachers to support key high technology courses. This shortage seems to be the result of teachers being both overworked and underpaid. The vo-tech teacher in the Georgia education system often has a highly marketable skill which places him in high demand by industry. Accordingly, he commands a high salary in the marketplace. Yet, teachers in the vo-tech system are paid very low salaries in proportion to their marketplace worth. System constraints frequently prevent salary adjustment and consequently, it is difficult to attract and retain qualified teachers. This problem must be corrected. We are not proposing that vo-tech teachers be given across-the-board increases, but rather that latitude be given to the schools hiring and promoting teachers to provide them with salaries commensurate with that offered in the marketplace. This also requires that schools be provided the staff funding to reflect these salary increases. Based on our review of industry wages, we think that the average salary for a teacher possessing a high technology skill will be between $25,000 and $30,000 per year (realizing there is wide variance in skills and experience among teachers). Using the low end of this range this would mean almost a doubling of teacher salaries in most cases and would require an increase of approximately $1.7 million annually in supplemental wages paid to teachers.

Higher salaries alone, however, will not provide the vo-tech system with a strong teaching staff. The current teacher spends an average of 30 hours/week teaching and counseling. This leaves very little time to keep up-to-date with changes in his given skill area. Teachers need more time to interact with industry and remain knowledgeable about the latest technological changes. We recommend that periodic leaves of absence be scheduled to allow teachers the opportunity to go back and work in an industry. This exposure will go a long way in allowing the teacher to become familiar with new equipment and new techniques and will also give industry exposure to the qualifications of individuals in the vo-tech system. However, such a recommendation means that more teachers will be needed not only meet the existing shortage of teachers but to handle the reduced teaching load proposed. Based on rough approximations, we estimate a need for approximately 135 additional teachers in the vo-tech system to support high technology demand. At an estimated average salary of $25,000 per year, the 85 additional teachers needed to handle the existing teacher shortage would result in an additional $2.1 million annually in new teacher wages. The remaining 50 new teachers needed to deal with reduced teaching work loads would cost the system very little since most of the teachers they would be supplementing would use their extra time to work for industry where they would be paid by industry for their services.

Industry has a rather large work force of qualified individuals who could instruct students in the area of new skills. In many cases, industry would be glad to share these individuals with the vo-tech system to help assure the students they receive have had relevant, up-to-date instruction. We recommend that industry personnel be incorporated liberally into high technology programs as guest instructors working side by side with vo-tech teachers. This relationship augments the quality and relevancy of program offerings and does so at a minimum cost to the state.

****

PROBLEM: The vo-tech system currently lacks a beacon to industry showing commitment to high technology needs.

PROPOSED SOLUTION: Design and implement a model school on the cutting edge of those technologies wiht the greatest economic impact on the State of Georgia.

****

There can be no disputing the fact that coordination and response are critical to attracting and retaining high technology industries. As was found from studying other states who are gearing up for high technology growth, the creation of resource centers is an effective means of concentrating efforts toward the goal of strong coordination and response.

The creation of resource centers is not an inexpensive proposition. To the extent that a single resource center can be centrally located in a known area of advanced technology growth, we feel that such a single center would adequately serve the entire vo-tech system and reduce overall costs by taking advantage of shared expertise and equipment among different program areas. Therefore, we propose the immediate development of a resource center or "model school" where the latest equipment is used, new curricula are evaluated, teachers are trained in new technical skills, and constant interaction with the national advanced technology scene is maintained.

This center can be achieved using one of several options. For instance, the center could be located in an existing vo-tech school, or in a school planned for near term introduction into the system but not yet completed, or in a totally new building and location not defined in the current expansion plan.

Obviously, for time and budgetary reasons, we feel that the use of an existing or planned school is best. Furthermore, the use of a planned facility allows changes to be incorporated into the overall design at a potentially lower cost than modifying an existing facility.

In support of a model school, we see the need for Georgia to have at least one school that can venture into the cutting edge of technology without diluting the current system effectiveness and without requiring funds well in excess of those considered reasonable. This school would have some of the latest equipment, such as laser machining tools and fiber optic troubleshooting devices, and could experiment with new curriculum offerings to ensure smooth presentation and integration of packages into the system. The school would also act as a training center for vo-tech teachers to provide needed skill updating to ensure that coordinated awareness exists across the system.

The model school will need to have a mechanism whereby it supports individual schools in the system by quickly implementing new programs to support industry needs. This is not to be confused with the Quick Start Program which provides industry with immediate training support. Rather this is a companion program designed to install permanent high technology progams quickly in schools throughout the system so that the local school can rapidly move to meet high technology industry needs.

Based on an order of magnitude estimate for a new school, equipment, and mobile support vehicles to interact with the existing vo-tech school system, we envision a brand new school costing about $25 million. Assuming that an existing or already planned structure could be utilized, the cost of upgrading that structure and outfitting it with necessary equipment would likely be in the $10 to $15 million range.

****

PROBLEM: The vo-tech system requires technical leadership to unify its approach to the challenge of future training needs.

PROPOSED SOLUTION: Establish a steering committee to define and direct vo-tech response to changes in high technology.

****

In order to further coordinate between the vo-tech system and advanced technology industry, we see the need for a steering committee which directs and defines the response of the vo-tech system to advanced technology changes. This committee must ensure that programs are in line with industry needs and that the vo-tech response to new and changing needs is sufficient to attract and retain high technology producers and users.

The committee would differ from the existing advisory committees in place by focusing only on high technology. Members would be selected from both industry and the educational community. These selected individuals would be conversant in the latest training techniques and the latest technological developments. This implies industrial trainers and research and development personnel would be prime candidates. In order to insure the committee could effectively carry out its mandate, it would report directly to the Governor. The committee should be chaired by an impartial third party knowledgeable in the areas of both high technology and industrial education. One such possibility is the use of university personnel. The committee would also contain one representative from the Governor's office and one from the office of the Superintendent of Schools to insure their inputs were considered in all recommendations issued.

Long Term

Focusing next on the long term, we found a developing need for new program offerings to be critical to meeting the high technology challenge.

****

PROBLEM: Current program offerings in the vo-tech system do not reflect forecasted employment opportunities over the next two decades.

PROPOSED SOLUTION: Implement fiber/laser optics and biology programs in order to strengthen our ability to attract these potential industries.

****

Our forecasts showed that Fiber/Laser Optics will become a significant new technology in Georgia between 1985 and 1990. Further, Biology will develop into an area requiring significant numbers of skilled employees around 1990. These two projections signal the need to begin plans for formulating curricula to support future industries in these areas. Putting new program offerings in place sooner than the forecast of significant need would encourage the growth of these two industrial sectors in Georgia.

****

PROBLEM: The growth of high technology will result in a greater demand for technicians with a broader base in related subjects and a deeper understanding of their own fields.

PROPOSED SOLUTION: Implement a two-year associate degree program within the vo-tech system and establish joint curricula with the junior colleges.

****

Engineering/scientific technicians are currently in short supply and as high technology industries grow, the gap between supply and demand will continue to widen. The engineering/scientific technician requires a more formal education than is currently provided by the vo-tech system. The balance between general scientific and mathematic offerings such as physics, engineering mechanics, and calculus and hands-on training with equipment such as is currently offered would differ significantly from the current emphasis on laboratory training. These technicians would be ultimately provided with an associate degree.

The vo-tech system provides a fertile ground for offering such a program. Close vo-tech association with industry coupled with the need for these technicians to be practically oriented point to the vo-tech system as the place to implement these two-year programs. However, this challenge would mean the hiring of college level professors capable of lecturing on college level topics in science and mathematics. We recommend that serious consideration be given to establishing joint curricula between the vo-tech schools and junior colleges system-wide to share the teaching talents of both systems. As a twist, however, we propose that the degree be granted by the vo-tech school which organizes and ultimately approves the qualifications for graduation.

APPENDIX A

Engineering and Science Technician Qualifications

Appendix A

ENGINEERING AND SCIENCE TECHNICIANS*

(D.O.T. 002. through 029.)

Nature of the Work

Knowledge of science, mathematics, industrial machinery, and processes enables engineering and science technicians to work in all phases of production, from research and design to manufacturing, sales, and customer service. Although their jobs are more limited in scope and more practically oriented than those of engineers or scientists, technicians often do work that engineers or scientists might otherwise have to do. Technicians frequently use complex electronic and mechanical instruments, experimental laboratory equipment, and drafting instruments. Almost all technicians described in this statement must be able to use engineering handbooks and computing devices such as slide rules and calculating machines.

In research and development (R&D), one of the largest areas of employment, technicians set up, calibrate, and operate complex instruments, analyze data, and conduct tests. They also assist engineers and scientists in developing experimental equipment and models by making drawings and sketches; and under an engineer's direction they frequently do routine design work.

In production, technicians usually follow the plans and general directions of engineers and scientists, but often without close supervision. They may prepare specifications for materials, devise tests to insure product quality, or study ways to improve the efficiency of an operation. They often supervise production workers to make sure they follow prescribed plans and procedures. As a product is built, technicians check to see that specifications are followed, keep engineers and scientists informed as to progress, and investigate production problems.

As sales workers or field representatives for manufacturers, technicians give advice on installation and maintenance problems of complex machinery, and may write specifications and technical manuals. (See statement on Technical Writers elsewhere in the *Handbook*.)

Technicians may work in the engineering field, in physical science, or in life science. Within these general fields, job titles may describe the level (biological aid or biological technician), duties (quality control technician or time study analyst), or area of work (mechanical, electrical, or chemical).

As an engineering technician, one might work in any of the following areas:

Aeronautical Technology. Technicians in this area work with engineers and scientists to design and produce aircraft, rockets, guided missiles, and spacecraft. Many aid engineers in preparing design layouts and models of structures, control systems, or equipment installations by collecting information, making computations, and performing laboratory tests. For example, under the direction of an engineer, a technician might estimate weight factors, centers of gravity, and other items affecting load capacity of an airplane or missile. Other technicians prepare or check drawings for technical accuracy, practicability, and economy.

Aeronautical technicians frequently work as manufacturers' field service representatives, serving as the link between their company and the military services, commercial airlines, and other customers. Technicians also prepare technical information for

*Source: Occupational Outlook Handbook

instruction manuals, bulletins, catalogs, and other literature. (See statements on Aerospace Engineers, Airplane Mechanics, and Occupations in Aircraft, Missile and Spacecraft Manufacturing elsewhere in the *Handbook*.)

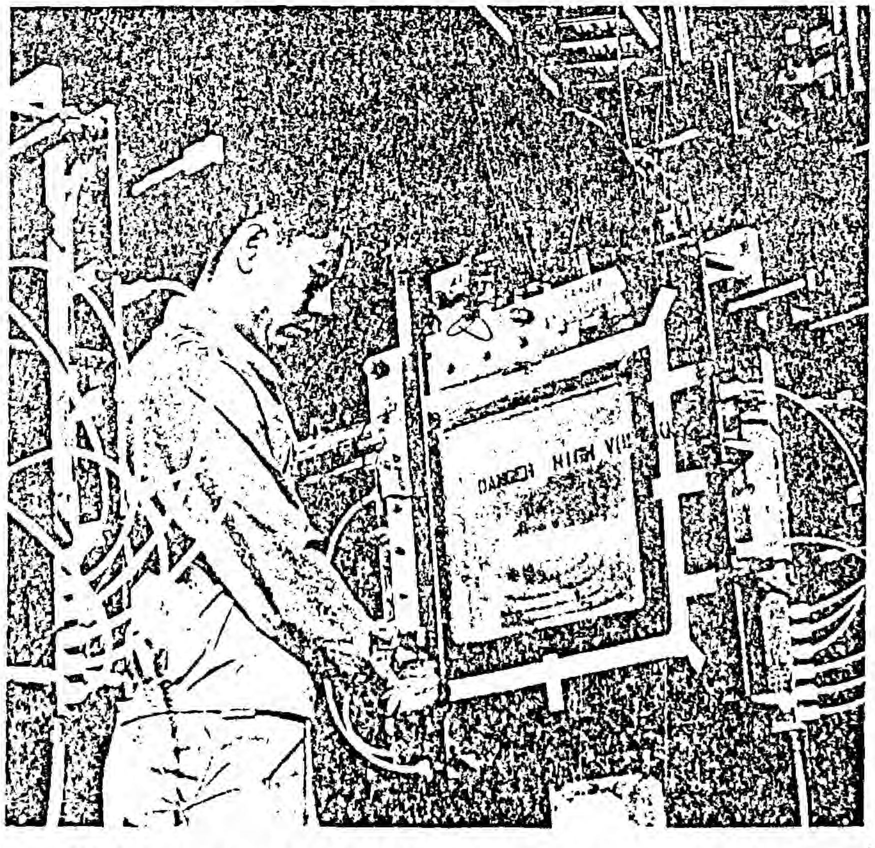
Air-Conditioning, Heating, and Refrigeration Technology. Air conditioning, heating, and refrigeration technicians design, manufacture, sell, and service equipment to regulate interior temperatures. Technicians in this field often specialize in one area, such as refrigeration, and sometimes in a particular type of activity, such as research and development.

When working for firms that manufacture temperature controlling equipment, technicians generally work in research and engineering departments, where they assist engineers and scientists in the design and testing of new equipment or production methods. For example, a technician may construct an experimental model to test its durability and operating characteristics. Technicians also work as field salesworkers for equipment manufacturers or dealers, and must be able to supply engineering firms and other contractors that design and install systems with information on installation, maintenance, operating costs, and the performance specifications of the equipment. Other technicians work for contractors, where they help design and prepare installation instructions for air-conditioning, heating, or refrigeration systems. Still others work in customer service, and are responsible for supervising the installation and maintenance of equipment. (See statement on Refrigeration and Air-Conditioning Mechanics elsewhere in the *Handbook*.)

Civil Engineering Technology. Technicians in this area assist civil engineers in planning, designing, and constructing highways, bridges, dams, and other structures. During the planning stage, they help estimate costs, prepare specifications for materials, or participate in surveying, drafting, or designing. Once construction begins, they assist the contractor or superintendent in scheduling construction activities or inspecting the work to assure conformance to blueprints and specifications. (See statements on Civil Engineers, Drafters, and Surveyors elsewhere in the *Handbook*.)

Electronics Technology. Technicians in this field develop, manufacture, and service a wide range of electronic equipment and systems. They may work with radio, radar, sonar, television, and other communication equipment, industrial and medical measuring or control devices, navigational equipment, electronic computers, and many other types of electronic equipment. Because the field is so broad, technicians often specialize in one area such as automatic control devices or electronic amplifiers. Furthermore, technological advancement is constantly opening up new areas of work. For example, the development of printed circuits stimulated the growth of miniaturized electronic systems.

When working in design, production, or customer service, electronic technicians use sophisticated measuring and diagnostic devices to analyze and test equipment. In many cases, they must understand the requirements of the field in which the electronic device is being used. In designing equipment for space exploration, for example, they must consider the need for minimum weight and volume and maximum resistance to shock, extreme temperature, and pressure. Some electronics technicians also work in technical sales, while others



Physics technician adjusts spark chamber during research experiment.

work in the radio and television broadcasting industry. (See statements on Broadcast Technicians and Occupations in Radio and Television Broadcasting elsewhere in the *Handbook.*)

Industrial Production Technology. Technicians in this area, usually called industrial or production technicians, assist industrial engineers on problems involving the efficient use of personnel, materials, and machines to produce goods and services. They prepare layouts of machinery and equipment, plan the flow of work, make statistical studies, and analyze production costs. Industrial technicians also conduct time and motion studies (analyze the time and movements a worker needs to accomplish a task) to improve the efficiency of an operation.

Many industrial technicians acquire work experience which enables them to qualify for other jobs. For example, those specializing in machinery and production methods may move into industrial safety. Others, in job analysis, may set job standards and interview, test, hire, and train personnel. Still others may move into production supervision. (See statements on Personnel Workers and Industrial Engineers elsewhere in the *Handbook.*)

Mechanical Technology. Mechanical technology is a broad term which covers a large number of specialized fields including automotive technology, diesel technology, tool design, machine design, and production technology.

Technicians assist engineers in design and development work by making freehand sketches and rough layouts of proposed machinery and other equipment and parts. This work requires knowledge of mechanical principles involving tolerance, stress, strain, friction, and vibration factors. Technicians also analyze the costs and practical value of designs.

In planning and testing experimental machines and equipment for performance, durability, and efficiency, technicians record data, make computations, plot graphs, analyze results, and write reports. They sometimes recommend design changes to improve performance. Their job often requires skill in the use of instruments, test equipment and gauges, as well as in the preparation and interpretation of drawings.

When a product is ready for production, technicians help prepare layouts and drawings of the assembly process and of parts to be manufactured. They frequently help estimate labor costs, equipment life, and plant space. Some mechanical technicians test and inspect machines and equipment in manufacturing departments or work with engineers to eliminate production problems. Others are technical salesworkers.

Tool designers are among the better known specialists in mechanical engineering technology. Tool designers design tools and devices for mass production, and frequently redesign existing tools to improve their efficiency. They prepare sketches of the designs for cutting tools, jigs, dies, special fixtures, and other attachments used in machine operations. They also make or supervise others in making detailed drawings of tools and fixtures.

Machine drafting, with some designing, is another major area often grouped under mechanical technology and is described in the statement on Drafters. (Also see statements on Mechanical Engineers, Automobile Mechanics, Manufacturers' Salesworkers, and Diesel Mechanics elsewhere in the *Handbook.*)

Instrumentation Technology. Automated manufacturing and industrial processes, oceanographic and space exploration, weather forecasting, satellite communication systems, environmental protection, and medical research have helped to make instrumentation technology a fastgrowing field for technicians. They help develop and design complex measuring and control devices such as those in a spacecraft that sense and measure changes in heat or pressure, automatically record data, and make necessary adjustments. These technicians have extensive knowledge of physical sciences as well as electrical-electronic and mechanical engineering. (See statement on Instrument Workers elsewhere in the *Handbook.*)

Several areas of opportunity exist in the physical sciences:

Chemical technicians work with chemists and chemical engineers to develop, sell, and utilize chemical and related products and equipment.

Most chemical technicians do research and development, testing, or other laboratory work. They often set up and conduct tests on processes and products being developed or improved. For example, a technician may examine steel for carbon, phosphorous, and sulfur content or test a lubricating oil by subjecting it to changing temperatures. The technician measures reactions, analyzes the results of experiments, and records data which will be the basis for decisions and future research.

Chemical technicians in production generally put into commercial operation those products or processes developed in research laboratories. They assist in making the final design, installing equipment, and training and supervising operators on the production line. Technicians in quality control test materials, production processes, and final products to insure that they meet the manufacturer's specifications and quality standards. Many also work as technical sales personnel, selling chemicals or chemical products.

Many chemical technicians use computers and instruments, such as a dilatometer (which measures the expansion of a substance). Because the field of chemistry is so broad, chemical technicians frequently specialize in a particular industry such as food processing or pharmaceuticals. (See statements on Chemists, Chemical Engineers, and Occupations in the Industrial Chemical Industry elsewhere in the *Handbook.*)

Meteorological technicians support meteorologists in the study of atmospheric conditions. Technicians calibrate instruments, observe, record, and report meteorological occurrences, and assist in research projects and the development of scientific instruments.

Geological technicians assist geologists in evaluating earth processes. Currently much research is being conducted in seismology, petroleum and mineral exploration, and ecology. These technicians install seismographic instruments, record measurements from these instruments, assist in field evaluation of earthquake damage and surface displacement, or assist geologists in earthquake prediction research. In petroleum and mineral exploration, they help conduct tests and record sound wave data to determine the likelihood of successful drilling, or use radiation detection instruments and collect core samples to help geologists evaluate the economic possibilities of mining a given resource.

Hydrologic technicians gather data to help professional hydrologists predict river stages and water quality levels. They monitor instruments which measure water flow, water table levels, or water quality, they analyze these data and report their findings to the hydrologist. (See statement on Environmental Scientists elsewhere in the *Handbook.*)

Technician positions in the life sciences are generally included in two categories: *Agricultural technicians* work with agricultural scientists in the areas of food production and processing. Plant technicians conduct tests and experiments to improve the yield and quality of crops, or to increase resistance to disease, insects, or other hazards. Technicians in soil science analyse the chemical and physical properties of various soils to help determine the best uses for these soils. Animal husbandry technicians concern themselves mainly with the breeding and nutrition of animals. In addition, several thousand technicians work in the food industry as food processing technicians. They work in quality control or in food science research, helping food scientists develop better and more efficient ways of processing food material for human consumption. (See statement on Food Scientists elsewhere in the *Handbook.*)

Biological technicians work primarily in laboratories where they perform tests and experiments under controlled conditions. Microbiological technicians study microscopic organisms and may be involved in immunology or parasitology research. Laboratory animal technicians study and report on the reaction of laboratory animals to certain physical and chemical stimuli. They also study and conduct research to help biologists develop cures which may be applied to human diseases.

Agricultural technician extracts grain sample for lab test.

Biochemical technicians assist biochemists in the chemical analysis of biological substances (blood, other body fluids, foods, drugs). Most of their work involves conducting experiments and reporting their results to a biochemist. As a biological technician, one might also work primarily with insects, studying insect control, developing new insecticides, or determining how to use insects to control other insects or undesirable plants. (See statements on Life Scientists elsewhere in the *Handbook.*)

Technicians also specialize in fields such as metallurgical (metal), electrical, and optical technology. In the atomic energy field, technicians work with scientists and engineers on problems of radiation safety, inspection, and decontamination. (See statement on Occupations in the Atomic Energy Field elsewhere in the *Handbook.*) New areas of work include environmental protection, where technicians study the problems of air and water pollution, as well as the field of industrial safety.

Places of Employment

Over 560,000 persons worked as engineering and science technicians in 1974. Almost 390,000 worked in engineering fields, about 125,000 in the physical science occupations, and about 50,000 in the life sciences. About 13 percent of all engineering and science technicians were women. The proportion of women technicians, by field, was 30 percent in life science; 15 percent in physical science; and 5 percent in engineering.

More than 375,000 (about 2 out of 3) technicians worked in private industry. In the manufacturing sector, the largest employers were the electrical equipment, chemicals, machinery, and aerospace industries. In nonmanufacturing, large numbers worked in wholesale and retail trade, communications, and in engineering and architectural firms.

In 1974, the Federal Government employed about 87,000 technicians, chiefly as engineering aids and technicians, equipment specialists, biological technicians, cartographic technicians (mapmaking), meteorological technicians, and physical science technicians. The largest number worked for the Department of Defense; most of the others worked for the Departments of Transportation, Agriculture, Interior, and Commerce.

State government agencies employed nearly 50,000 engineering and science technicians, and local governments about 11,000. The remainder worked for colleges and universities and nonprofit organizations.

Training, Other Qualifications, and Advancement

Persons can qualify for technician jobs through many combinations of work experience and education because employers traditionally have been flexible in their hiring standards. However, most employers prefer applicants who have had some specialized technical training. Specialized training is available at technical institutes, junior and community colleges, area vocational-technical schools, extension divisions of colleges and universities, and vocational-technical high schools. Engineering and science students who have not completed the bachelor's degree and others who have degrees in science and mathematics also are able to qualify for technician positions.

Persons can also qualify for technician jobs by less formal methods. Workers may learn through on-the-job training programs or courses in post-secondary or correspondence schools. Some qualify on the basis of experience gained in the Armed Forces. However, post-secondary training is increasingly necessary for advancement to more responsible jobs.

Some of the types of post-secondary and other schools which provide technical training are discussed in the following paragraphs:

Technical Institutes. Technical institutes offer training to qualify students for a job immediately after graduation with a minimum of on-the-job training. In general, students receive intensive technical training but less theory and general education than in engineering schools or liberal arts colleges. A few technical institutes and community colleges offer cooperative programs; students spend part of the time in school and part in paid employment related to their studies.

Some technical institutes operate as regular or extension divisions of colleges and universities. Other institutions are operated by States and municipalities, or by private organizations.

Junior and Community Colleges. Curriculums in junior and community colleges which prepare students for technician occupations are similar to those in the freshman and sophomore years of 4-year colleges. After completing the 2-year program, graduates can transfer to 4-year colleges or qualify for some technician jobs. Most large community colleges offer 2-year technical programs, and many employers prefer graduates having more specialized training.

Area Vocational-Technical Schools. These post-secondary public institutions serve students from surrounding areas and train them for jobs in the local area. Most of these schools require a high school degree or its equivalent for admission.

Other Training. Some large corporations conduct training programs and operate private schools to meet their needs for technically trained personnel in specific jobs; such training rarely includes general studies. Training for some technician occupations, for instance tool designers and electronic technicians, is available through formal 2- to 4-year apprenticeship programs. The apprentice gets on-the-job training under the close supervision of an experienced technician and related technical knowledge in classes, usually after working hours.

The Armed Forces have trained many technicians, especially in electronics. However, military job requirements are generally different from those in the civilian economy. Thus, military technician training may not be adequate for civilian technician work, and additional training may be necessary for employment.

Technician training also is available from many private technical and correspondence schools that often specialize in a single field such as electronics. Some of these schools are owned and operated by large corporations that have the resources to provide very up-to-date training in a technical field.

Those interested in a career as a technician should have an aptitude for mathematics and science, and enjoy technical work. An ability to do detailed work with a high degree of accuracy is necessary; for design work, creative talent also is desirable. Since technicians are part of a scientific team, they sometimes must work under the close supervision of engineers and scientists as well as with other technicians and skilled workers.

Engineering and science technicians usually begin work as trainees in routine positions under the direct supervision of an experienced technician, scientist, or engineer. As they gain experience, they receive more responsibility and carry out a particular assignment under only general supervision. Technicians may eventually move into supervisory positions. Those who have the ability and obtain additional education are sometimes upgraded to professional science or engineering positions.

Employment Outlook

Employment opportunities for engineering and science technicians are expected to be favorable through the mid-1980's. Opportunities will be best for graduates of post-secondary school technician training programs. Besides the openings resulting from faster than average growth expected in this field, additional technicians will be needed to replace those who die, retire, or leave the occupation.

Industrial expansion and the increasing complexity of modern technology underlie the anticipated increase in demand for technicians. Many will be needed to work with the growing number of engineers and scientists in developing, producing, and distributing new and technically advanced products. Automation of industrial processes and growth of new work areas such as environmental protection and urban development will add to the demand for technical personnel.

The anticipated growth of research and development (R&D) expenditures in industry and government should increase demand for technicians. However, this growth is expected to be slower than in the past.

Because space and defense programs are major factors in the employment of technical personnel, expenditures in these areas affect the demand for technicians. The outlook for technicians is based on the assumption that defense spending will increase from the 1974 level by the mid-1980's, but will still be slightly lower than the levels of the late 1960's. If defense spending should differ substantially from this level, the demand for technicians would be affected accordingly.

Earnings

In general, technicians' earnings depend on their education and technical specialty, as well as their ability and work experience, and the industry in which they work.

In private industry in 1974, average starting salaries for 2-year graduates ranged from about $8,200 to $9,800 a year, while nongraduates earned average starting salaries from just over $6,000 to about $8,500. Starting salaries for bachelor's degree recipients averaged over $10,000 a year. According to a 1974 Bureau of Labor Statistics survey, experienced engineering technicians in private industry earned average salaries of about $13,500 a year.

Starting salaries for all technicians in the Federal Government were fairly uniform in late 1974. A high school graduate with no experience could expect $5,996 annually to start. With an associate degree, the starting salary was $7,596, and if a bachelor's degree were held, the annual salary might be $8,500 or $10,520 (depending on the type of job vacancy and the applicant's education and other qualifications). At higher experience levels, however, differences in earnings are significant. The average annual salary for all engineering technicians employed by the Federal Government in late 1974 was $16,000; for physical science technicians, $15,000; and for life science technicians, about $11,000.

Sources of Additional Information

For information on careers for engineering and science technicians and engineering and technology programs, contact:

Engineers Council for Professional Development, 345 East 47th St., New York, N.Y. 10017.

Information on schools offering technician programs is available from:

National Association of Trade and Technical Schools, Accrediting Commission, 2021 L St. NW., Washington, D.C. 20036.

U.S. Department of Health, Education, and Welfare, Office of Education, Washington, D.C. 20202.

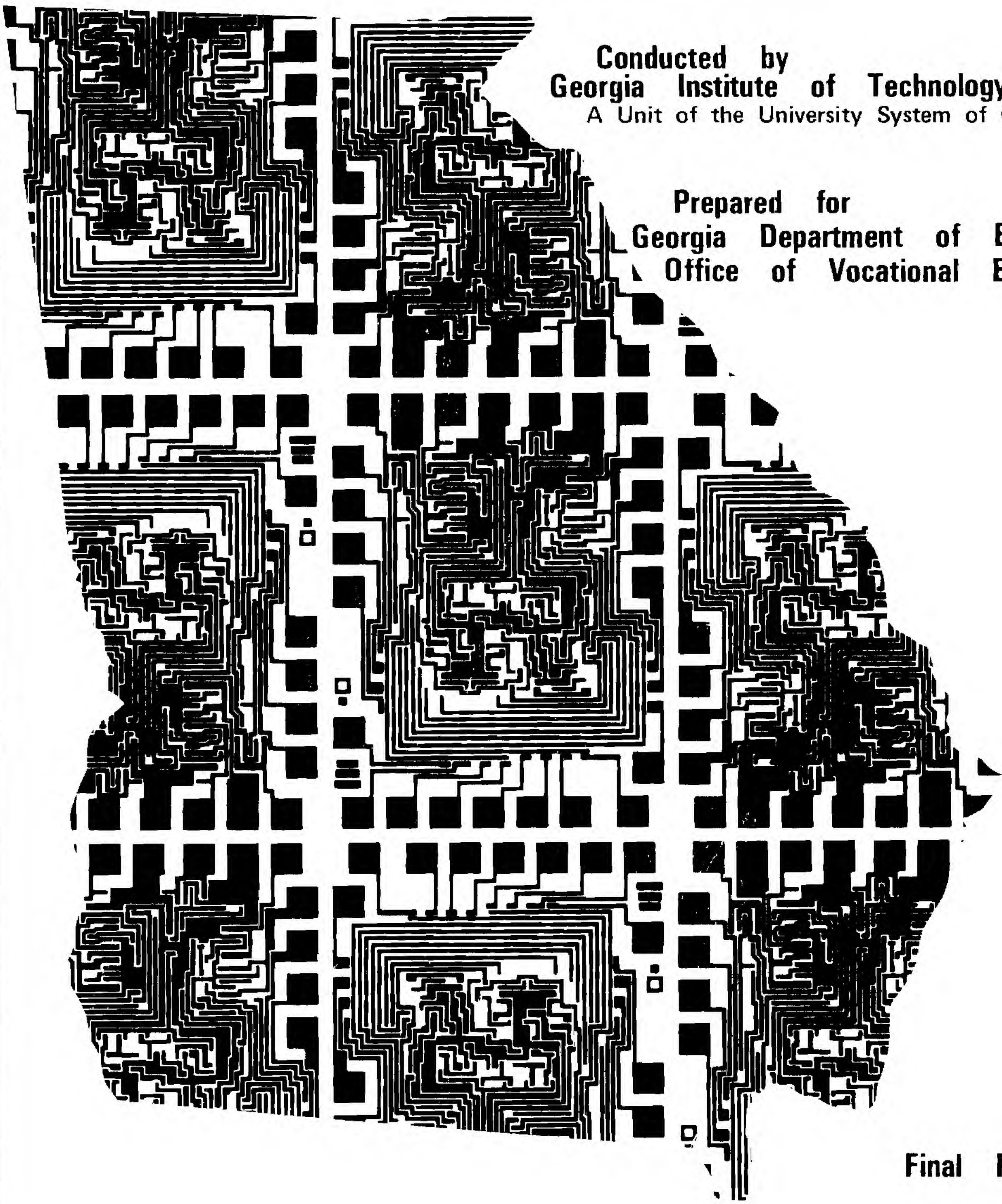
State departments of education also have information about approved technical institutes, junior colleges, and other educational institutions within the State offering post-high school training for specific technical occupations. Other sources include:

American Association of Community and Junior Colleges, Suite 410, 1 Dupont Circle, Washington, D.C. 20036.

National Home Study Council, 1601 18th St. NW., Washington, D.C. 20009.

A-2995

AN ADVANCED TECHNOLOGY STUDY FOR POST-SECONDARY AREA VOCATIONAL-TECHNICAL SCHOOLS



Conducted by
Georgia Institute of Technology
A Unit of the University System of Georgia

Prepared for
Georgia Department of Education
Office of Vocational Education

Final Report

Project A-2995

AN ADVANCED TECHNOLOGY STUDY
FOR POST-SECONDARY AREA VOCATIONAL-TECHNICAL SCHOOLS

Final Report

Submitted to

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Prepared by

C.L. Aton, Project Director
H.W. Hodges
F.A. Tarpley
V.A. Thomas
J.C. Wyvill

GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia 30332

August 1982

DISCLAIMER

This publication was prepared pursuant to an agreement with the State Board of Education of the State of Georgia. Contractors undertaking such projects under government sponsorship are encouraged to freely express their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent the official policy of The Board of Education of the State of Georgia or the U.S. Department of Education.

TABLE OF CONTENTS

	Page
Acknowledgments	xi
Preface	xiii
I. INTRODUCTION	1
II. ADVANCED TECHNOLOGY AND THE NEED FOR TECHNICALLY TRAINED WORKERS IN GEORGIA	9
A. Introduction	9
B. Definition of High Technology	11
C. Methodology and Approach	12
D. Employment Projections	16
1. Computer Services	16
2. Computer Manufacturing	20
3. Communications	24
4. Avionics	26
5. Laser Technology	28
6. Biotechnology	31
7. Solar Energy	34
8. Projected National and Statewide Impacts of Industrial Automation	37
E. Implications for Training	42
III. AN INVESTIGATION OF HIGH TECHNOLOGY TRAINING NEEDS FROM AN INDUSTRIAL PERSPECTIVE	47
A. Introduction	47
B. Survey Methodology	47
C. Survey Results	51
D. Evaluation of Findings	60
E. Problem Areas	61
IV. SCHOOL SYSTEM'S PERCEPTION OF THE CURRENT VO-TECH SYSTEM IN GEORGIA	65
A. Introduction	65
B. Georgia's Current System	65
1. Educational Structure	65
2. Program Offerings	66
3. Teacher Update	68
4. Industry/School Interface	70
5. Teacher Salaries	71
6. Vo-Tech Image	72
7. The Economy	73
C. Survey of Vocational Technical School Directors	73
1. Perceived Barriers	73
2. Perceived Changes Required	84

TABLE OF CONTENTS (Cont'd)

	Page
V. APPROACHES TO SIMILAR PROBLEMS IN OTHER STATES	89
A. Introduction	89
B. Problems in Common With Other States..................	90
1. Educational Structure	90
2. Program Offerings	91
3. Teacher Updates	92
4. Industry/School Interface	94
5. Teacher Salaries	95
6. Vo-Tech Image	95
7. The Economy	95
C. Arkansas	96
1. Educational Structure	96
2. Program Offerings	99
3. Teacher Updates	100
4. Industry-School Interface	100
5. Teacher Salaries	101
6. Vo-Tech Image	101
7. The Economy	102
D. California	103
1. Educational Structure	103
2. Program Offerings	103
3. Teacher Updates	104
4. Industry-School Interface	104
5. Teacher Salaries	106
6. Vo-Tech Image	106
7. The Economy	107
E. Florida	107
1. Educational Structure	107
2. Program Offerings	108
3. Teacher Updates	109
4. Industry-School Interface	109
5. Teacher Salaries	110
6. Vo-Tech Image	110
7 The Economy	111
F. Massachusetts	112
1. Educational Structure	112
2. Program Offerings	112
3. Teacher Updates	112
4. Industry-School Interface	113
5. Teacher Salaries	113
6. Vo-Tech Image	114
7. The Economy	114

TABLE OF CONTENTS (Cont'd)

	Page
V. APPROACHES TO SIMILAR PROBLEMS IN OTHER STATES (Continued)	
G. North Carolina	114
1. Educational Structure	114
2. Program Offerings	115
3. Teacher Updates	115
4. Industry-School Interface	116
5. Teacher Salaries	117
6. Vo-Tech Image	117
7. The Economy	118
H. Oregon	119
1. Educational Structure	119
2. Program Offerings	119
3. Teacher Updates	120
4. Industry-School Interface	121
5. Teacher Salaries	124
6. Vo-Tech Image	124
7. The Economy	124
I. South Carolina	125
1. Educational Structure	125
2. Program Offerings	125
3. Teacher Updates	126
4. Industry-School Interface	126
5. Teacher Salaries	127
6. Vo-Tech Image	127
7. The Economy	127
J. Texas	127
1. Educational Structure	127
2. Program Offerings	128
3. Teacher Updates	129
4. Industry-School Interface	129
5. Teacher Salaries	130
6. Vo-Tech Image	130
7. The Economy	131
VI. FINDINGS, NEEDS, AND RECOMMENDATIONS	133
A. Introduction	133
B. Findings	133
1. High Technology Trends	133
2. High Technology Skills	134
3. Barriers	134
C. Needs	135
1. Programs	135
2. Delivery Systems	137
3. Equipment	140
4. Staff	140

TABLE OF CONTENTS (Cont'd)

Page

VI. FINDINGS, NEEDS, AND RECOMMENDATIONS (Continued) ....

D. Recommendations 143
1. System Needs 143
2. Program Needs 145
3. Staff Needs 147

APPENDICES

A. Vo-tech Schools Offering High Tech Programs
B. Manufacturing Component of Work Force
C. Engineering & Scientific Technicians
D. Copy of School Survey Questionnaire
E. Placement Data for Selected High Technology Training
F. List of Contacts for Eight Other States
G. List of Recommended Equipment

LIST OF TABLES

Table Number	Title	Page
1-1	State and Area Post-Secondary Vocational Technical Schools Total Enrollment for 1967 and 1980	5
1-2	Day Enrollment in Selected High Technology Programs, 1980-1981	6
2-1	Anticipated Employment Increases	17
2-2	Major Applications of Lasers for Industrial Processes and Energy Generation	30
2-3	Jobs in the U.S. That Will Be Directly Affected by Automation, 1980-2000	39
2-4	Functions of Robots on the Auto Assembly Line	40
2-5	Required Production Workers and Technicians in Georgia	45
3-1	Types of High Technology Firms Currently Located in Georgia	48
3-2	Overview of Companies Surveyed	49
3-3	Demand for Technically Trained Workers by Size of Firm	53
3-4	Titles of Jobs Requiring Vo-Tech Skills Based on Survey of 20 Firms	54
3-5	Methods of Recruitment for High Technology Vo-Tech Graduates	58
3-6	Training Deficiencies Reported by Industry	59
4-1	Vo-Tech Program Locations	67
4-2	Placement Data in Selected High Technology Programs, 1981	83

LIST OF TABLES (Cont'd)

Table Number	Title	Page
4-3	Vocational-Technical School Directors' Evaluation of Changes Necessary to Bring High Technology Courses to State-of-the-Art	87
5-1	General Education Requirements for Associate Degrees Offered in Vocational-Technical Fields	93
5-2	Summary of Responses by Eight States and Georgia to Seven Aspects of Vocational-Technical Training	97
6-1	Selected List of Basic Skills Demanded of Technicians in High Technology Firms	136
6-2	Recommended Delivery Systems	139
6-3	Basic Level Teaching Equipment	141
6-4	Pilot Level Teaching Equipment	141

LIST OF FIGURES

Figure Number	Title	Page
1-1	Location of Vocational-Technical Schools	4
2-1	Anticipated Annual New Employment in Georgia by Area	43
3-1	Proportion of Vo-Tech Technicians to Full Labor Force for 14 Georgia High Technology Firms	52
3-2	Job Description Comparison	55
4-1	Barriers Perceived by Area School Directors	75

ACKNOWLEDGMENTS

The authors wish to acknowledge the timely cooperation and enthusiasm of the area school directors and teachers as well as the knowledgeable assistance of staff in the Office of Vocational Education. Industry training personnel and training leaders in other states are also acknowledged for the insights and information provided. A note of appreciation goes to those who assisted us in preparing the Interim Report--R.D. Atkins, J. Banks, D. Betten, G.E. Kearney, R.G. Schwartz, and J.L. Walsh--for laying the foundation upon which this Final Report is based, and to T.F. McGowan and L.T. Rockett for their assistance in preparing a recommended list of training equipment.

A special thanks goes to Robert K. Mabry, our Technical Coordinator, for his professional support of our efforts.

PREFACE

The Office of Vocational Education at the Georgia Department of Education had the foresight to see that the state's post-secondary vocational-technical schools might not be able to keep pace with the advancements in technology. And this lag would occur at an inopportune time, because the Governor of Georgia was actively pursuing plans to attract high technology industry to the state, including the establishment of the Advanced Technology Development Center (ATDC) on the Georgia Tech campus. One of the foremost needs of the high technology industrial sector is a readily available skilled work force, a factor that could ultimately determine the viability of Georgia as a site for new high technology industry.

Consequently, the Office of Vocational Education contracted with the Georgia Institute of Technology in June 1981 to define directions and strategies for meeting training needs and providing a competitive edge in attracting this fast-paced, high growth industry to our state. At the same time, the Governor requested a background paper he could use in setting priorities for budget planning in the fall of 1981. This accelerated need for information culminated in an Interim Report, published in October 1981.

In that Interim Report, recommendations were made in four areas for the near term and two areas for the long term. It was recommended that electronics equipment be upgraded and that an equipment sharing program be developed. It was recommended that teacher salaries be increased, that more updating opportunities be provided, and that industry personnel be used as guest instructors. Other near term recommendations were to establish a model school on the cutting edge of technology and appoint a steering committee to define and direct vo-tech responses to high technology needs. The two long term recommendations were to implement programs in fiber/laser optics and biology as well as implement a two-year associate degree program within the vo-tech system including joint curricula with the junior colleges.

Governor Busbee and the Office of Vocational Education took immediate action in three of the near term areas and one of the long term areas:

- An $8 million budget was established to upgrade equipment.

- Three pilot schools were chosen in which to accelerate implementation of high technology programs.

- A High Technology Advisory Council was appointed and a position for High Technology Coordinator was established.

- A curriculum based on Accreditation Board for Engineering Technology (ABET) criteria was proposed for a two-year degree program.

Thus, even as this report was being completed, major steps were being taken to move the post-secondary vocational-technical school system out of a reactive response mode into an active leadership role in the area of high technology training. It is with this in mind that the reader should examine this final report.

SECTION I

INTRODUCTION

Economic development during the 1980's is predicted to center on high technology industries. National projections for high technology growth predict 7.1 million jobs and a $402 billion increase in sales over the next two decades.

In order for Georgia to develop its share of what is undoubtedly the fastest growing sector of the economy, efforts must be made to identify and fulfill the needs of high technology industries. An extremely important factor in attracting the interest of high technology firms is a visible commitment by government (as evidenced by the ability and willingness of a state to provide skilled technicians).

Well-trained, specialized workers are necessary both for the manufacture and use of most high technology products. The availability and quality of high technology educational programs is crucial to attracting new industry and encouraging the expansion of existing firms.

Industry need for highly trained technicans is so great that in many states, including Georgia, companies are hiring high technology students before they finish their programs. Intense competition among firms for the limited number of technicians presently available has led to high salary offers. In turn, career opportunities in high technology are attracting ever greater numbers of students, many of whom are experienced in the work place, and quick to recognize the potential advantages of high technology training provided by the vocational-technical school system.

The purpose of this study was to determine the level and extent of post-secondary vocational-technical training in advanced technologies necessary to meet current and projected industry needs.

The objectives of this study were to:

- Identify trends in societal and industrial change, as well as in associated technologies, and describe the resultant implications for training technicians in Georgia's post-secondary vocational-technical schools for the next 10 years and the next 20 years.

- Identify competencies for those technologies determined to be significant for training technicians to serve the needs of existing, expanding, and new industries in Georgia.

- Examine existing technology programs in area vocational-technical schools and determine the difference between those significant technologies which are taught and those which should be taught.

- Define new curriculum areas which are needed (or will be needed) and any necessary modifications in existing technical programs.

- Define and recommend the best delivery systems for high technology programs.

- Identify barriers to implementing recommendations.

- Define changes which should be made to overcome identified barriers.

- Recommend relatively inexpensive measures which should be implemented within 3 years; measures of intermediate cost which should be implemented within 3 to 10 years; and measures requiring extensive change and substantial costs which should be implemented over 10 to 20 years.

The results of this study show that the vo-tech system in Georgia must move quickly to provide for the evolving and growing needs of innovative quick-paced industry. Graduates from the vo-tech system must be taught the new skills required to meet industry's needs and attract additional high technology companies to Georgia.

The State of Georgia has demonstrated its commitment to provide a comprehensive vocational education program that is accessible to every adult and every in-school student in the state. The extensive network of post-secondary vocational-technical schools funded by the State Legislature and operated by the Georgia Department of Education is testimony to this commitment. Starting in 1960 with only two post-secondary vocational-technical schools (North Georgia Tech at Clarkesville and South Georgia Tech at Americus) and a full-time enrollment of approximately 1,000 students, by 1980 the vo-tech system had grown to 24 post-secondary vocational-technical schools, 5 adult vocational centers, and 3 joint Junior College programs, in addition to the 2 state-operated schools of North and South Georgia. Figure 1-1 shows the location of these schools, 29 of which offer at least one high technology program. (A listing of schools offering high technology programs is shown in Appendix A.)

Steady enrollment increases in full-time and part-time programs and special on-campus and off-campus courses reflect state and federal legislative commitment to vocational education. Table 1-1 illustrates the increased enrollment at area vocational-technical schools since 1967. Day enrollment more than tripled between 1967 and 1980, exemplifying intensified interest in both traditional and new training programs, while short-term enrollment which represents adult updating or retraining programs serves an even greater population.

As the need for high technology workers has increased, vocational-technical schools have expanded their programs to include appropriate training. In Table 1-1, 1980 enrollment in those high technology programs initially selected by the Division of Program Development is shown as a percentage of day enrollment.

High technology programs, as shown in Table 1-2, are currently concentrated in five technology areas where jobs are more available. These are

FIGURE 1-1

LOCATION OF VOCATIONAL-TECHNICAL SCHOOLS

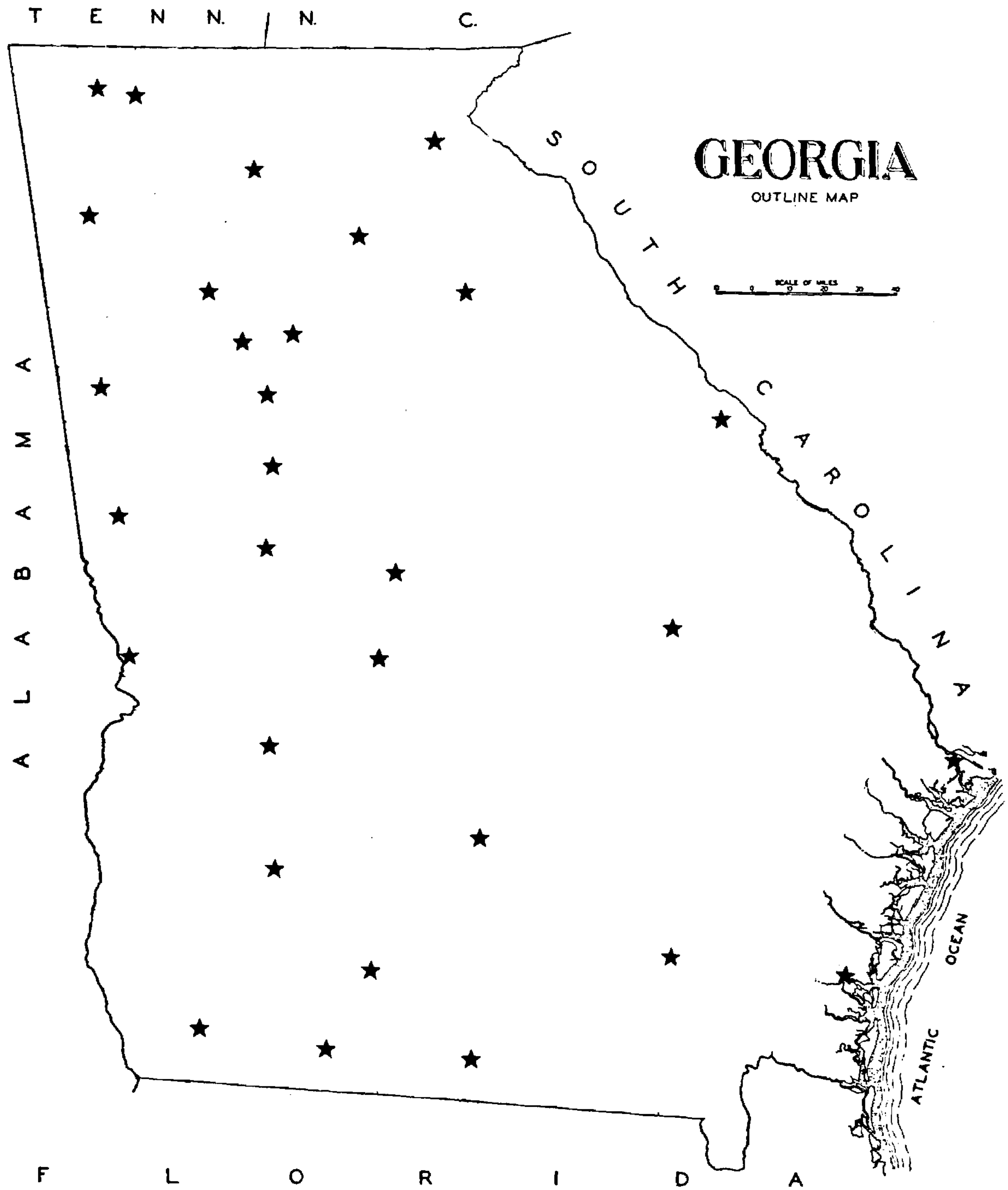


TABLE 1-1
STATE AND AREA POST-SECONDARY VOCATIONAL-TECHNICAL SCHOOLS
TOTAL ENROLLMENT FOR 1967 AND 1980

Vocational-Technical School	1967	1980*		Selected High Technology Enrollment as % of Day Enrollment, 1980
		Day	Short-term	
Albany	544	1,296	2,050	8.9%
Athens	485	1,728	5,485	19.6
Atlanta	967	3,053	7,271	11.2
Augusta	786	2,255	3,941	11.0
Bainbridge Jr. College	-	328	305	3.0
Ben Hill-Irwin	-	713	1,009	7.0
Brunswick Jr. College	-	498	928	10.4
Carroll	32	942	1,551	7.3
Columbus	658	2,171	2,508	12.6
Coosa Valley	358	1,236	2,374	14.6
Dalton Jr. College	-	661	925	17.7
DeKalb	733	2,144	9,483	28.5
Griffin-Spalding	230	1,237	1,535	16.6
Houston Vocational Center	-	687	518	12.7
Lanier	172	685	2,401	20.4
Macon	542	1,917	6,348	11.9
Marietta-Cobb	501	1,695	3,823	19.5
Moultrie	207	649	1,778	8.5
North Georgia	704	1,139	2,475	15.9
Pickens	157	599	1,176	15.9
Savannah	552	1,563	2,390	7.4
South Georgia	610	897	913	14.0
Swainsboro	206	525	2,272	10.9
Thomas	340	687	1,316	16.2
Troup	144	622	1,770	9.2
Upson	217	603	836	11.8
Valdosta	248	958	1,490	11.9
Walker	267	740	1,295	22.7
Waycross-Ware	249	857	1,660	9.1
TOTALS	9,909	33,085	71,826	14.0% Average

*Full-time and part-time unduplicated count.

Sources: A Study of Staffing Needs of Post-Secondary Vocational-Technical Schools in Georgia, Georgia Department of Education, Office of Vocational Education, July 1981.

Student (Product) Evaluation, Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring, 1981: Georgia Vocational Management Information System, September 1981.

Table 1-2

DAY ENROLLMENT
IN SELECTED HIGH TECHNOLOGY PROGRAMS
1980-1981

Area Vocational-Technical School	Total	Computer Related	Electronic Technology	Electro-Mechanical Technology	Drafting Occupations	Mechanical Technology
Albany	115	42	41	--	7	25
Athens	338	82	130	52	39	35
Atlanta	342	112	147	--	83	--
Augusta	249	82	116	--	---	51
Bainbridge Jr. College	10	10	---	--	---	--
Ben Hill - Irwin	50	---	---	31	19	--
Brunswick Jr. College	52	49	---	--	---	3
Carroll	69	32	---	--	37	--
Columbus	273	103	140	--	4	26
Coosa Valley	180	82	56	--	---	42
Dalton Jr. College	117	76	15	--	26	--
DeKalb	610	312	141	23	100	34
Griffin-Spalding	205	128	41	--	36	--
Houston Voc. Ctr.	87	---	41	--	46	--
Lanier	140	78	62	--	---	--
Macon	228	100	77	--	---	51
Marietta-Cobb	330	166	89	38	37	--
Moultrie	55	---	37	--	---	18
North Georgia	181	42	75	--	---	64
Pickens	95	36	31	--	---	28
Savannah	116	51	22	--	---	43
South Georgia	126	31	61	--	34	--
Swainsboro	57	---	33	--	24	--
Thomas	111	47	41	--	---	23
Troup	57	---	32	--	25	--
Upson	71	---	39	--	32	--
Valdosta	114	73	41	--	---	--
Walker	168	51	64	--	---	53
Waycross-Ware	78	30	25	--	23	--
TOTALS	4,624	1,815	1,597	144	572	496

Source: Student (Product) Evaluation, Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring, 1981: Georgia Vocational Management Information System, September 1981.

computer-related programs, drafting occupations, mechanical technology, electronic technology and electromechanical technology. Computer-related courses are most widespread, with electronic technology courses almost as prominent. About half the vocational-technical schools offer programs for drafting occupations and mechanical technology. Fewer schools offer electromechanical technology because it is a newer curriculum frequently requiring expensive new equipment and additional instructors. While these five areas are representative of current high technology offerings, available programs vary from school to school based on local employment conditions.

Though occupational training provided by the vo-tech schools serves the needs of individual students as well as the needs of business and industry, the bottom line for vo-tech training is employment. Programs are initiated, continued, or discontinued on the basis of employment opportunities and student demands for specific training. These in turn depend on demand from a rapidly changing set of industries. As a consequence, vocational education directed toward high technology is necessarily responding to a moving target. At the same time, school officials, guidance counselors, parents, and students are learning more about high technology, and enrollments in vocational-technical school high technology programs continue to rise. High technology education is a dynamic system of existing and anticipated demand and ever larger and more competitive supply.

Vocational-technical schools must be ready for the challenge. It may take two years to prepare a curriculum and two more years to train workers, so that educators must plan for industry needs at least four years in advance. Therefore, a long range but flexible approach is necessary.

This final report presents findings and recommendations for such an approach. It is divided into the following sections:

- Section II identifies trends in high technology and the implications for training technicians over the next two decades.

- Section III identifies skills and program elements lacking in current vo-tech graduates and program offerings, respectively, as well as current barriers to the implementation of effective high technology programs as perceived by high technology industry.

- Section IV describes the existing vo-tech system in Georgia and examines it from the school directors' perspective with regard to barriers and modifications required to meet high technology industry needs.

- Section V presents the problems in common with eight other states in overcoming training barriers as well as their varied approaches to high technology training.

- Section VI presents findings, needs, and recommendations for implementing effective high technology training programs in Georgia using a long range but flexible approach.

SECTION II

ADVANCED TECHNOLOGY AND THE NEED FOR TECHNICALLY TRAINED WORKERS IN GEORGIA

A. INTRODUCTION

The State of Georgia must compete with other states both nationally and regionally for high technology industries and jobs. The increasing volume of jobs and sales projected nationally for this sector of the economy has engendered such competition. If Georgia is to meet the competitive challenge and ensure continued economic growth, attention must be focused on further developing existing capacity to meet the requirements of high technology training.

Nationally, the emergence of new technologies and the development of new technology-based industries have been a major source of economic growth. However, the growth of technology-oriented industry and the concomitant growth in the number of highly skilled and paid employees (both professional and supporting skilled technicians) has not occurred uniformly across the United States. The largest concentration of high technology firms, approximately 800 companies, is in Santa Clara County, the well-known "Silicon Valley" south of San Francisco, California. Between 1959 and 1976, employment in the Silicon Valley grew from approximately 5,000 to 70,000. Other areas in California, the area around Boston, portions of Colorado, Oregon, Utah, and Texas have all experienced rapid employment growth associated with the emergence of high technology industries.

Many benefits can be derived from the growth of a high technology industrial base and the adoption of emerging technologies by existing firms. Most emerging technologies are environmentally benign, eliminating the need for discomforting trade-offs between jobs and a clean environment. They typically are capital-intensive and hence create local wealth. Employees in this sector of industry generally have received advanced training and can demand relatively high salaries. Most important, the development of high technology companies produces jobs. For example, Data General was born in the Boston area around Route 128. This minicomputer company, which now employs over 5,000 people, increased its employment at an annual rate of 66% over a three-year period.

Technology-based industry in the Southeast has generally grown more slowly than in other areas that have been viewed as providing a climate more conducive to high technology growth. Recent growth in Central Florida, in North Carolina around the Research Triangle, and in the Atlanta area indicates, however, that the potential does exist in this region for significant technology-based industrial and employment development. Failure to realize the potential for industrial development of this kind could severely stunt the economies of the southern states. Additionally, a failure to incorporate emerging technologies such as process control and computer automation into existing industry will compound the region's problems.

Unfortunately, Georgia may not be in the forefront in competing for high technology industries. A major cause of Georgia's lag is its short supply of workers with the skills necessary to attract and support high technology business and to facilitate the introduction of the latest technology into existing industries. Vocational education within the state has traditionally received a level of support inadequate to train in depth a sufficient number of workers in the skills required to support a strategy of technology-based development.

The purpose of this section is to estimate the direction and extent of the need for technicians with various types of skills during the rest of this century. This is a complex task for a number of reasons, but two are especially noteworthy.

First, the skills that will be needed are dependent on the technologies that emerge. Rapid innovation, a hallmark of high technology industries, can completely alter the type of technical support skills an industry requires. For example, in the early days of solid state devices, persons with doctorates in chemical engineering grew the needed germanium crystals. Today the process is automated, and a person with minimal training can supervise several machines.

Second, the economic profile of Georgia will undoubtedly change. If Georgia is successful in attracting technology-based industries and modernizing existing industries, the need for technically trained workers will significantly increase. On the other hand, if Georgia's traditional industries fail to incorporate advances in process control and automation, and Georgia fails to attract and develop technology-based businesses, the decline in the number of skilled jobs will reflect this lack of progress.

Difficulties encountered in estimating the need for various types of technicians should not serve as a deterrent. Rather, Georgia should continuously monitor its need for technicians in the light of its economic development goals and an ever-improving understanding of technological trends. Moreover, this monitoring should be integrated with the planning process for vocational education within the state.

B. DEFINITION OF HIGH TECHNOLOGY

In order to discuss the vocational skills needed to support high technology industrial development, it is important to define, or at least characterize, "high technology." K. Nagaraja Roa of the Massachusetts Institute of Technology (MIT) has developed a definition that treats high technology as a relative concept based on several characteristics. Technology is classified as "high" to the extent that it is based on scientific and technological knowledge; integrates that knowledge with technical skills; is based on a high level of research and development activity; is radically new in its scientific and technical content; and incorporates an advanced level of automation in manufacture and production control.

Clearly, the recent activity in such areas as electronics, communications, computers, and avionics--which promise major contributions in terms of sales and employment--suit this definition. Also, certain areas such as computer-directed process control, which are being increasingly used in more traditional industries, could be classified as high technology. The emphasis that this definition places on scientific and technical knowledge and on the integration of this knowledge with technical skills makes it particularly appropriate to discussions of the role of vocational education in supporting the development of high technology in Georgia.

Obviously, not all vocational education programs in Georgia are aimed at supporting high or advanced technology needs. Traditional industries will continue to need technically trained people with traditional skills, although recent technological improvements may well affect what they do and how they do it. For example, recent advances in computer-aided design (CAD) systems will change the way drafters work and, in some cases, what sort of work is done, but drafting fundamentals remain the same. Similarly, many high technology industries will need people trained in traditional vocational skills.

C. METHODOLOGY AND APPROACH

The traditional approach to estimating the need for persons with various kinds of technical skills or training has been to develop extrapolations based on previous employment patterns. However, this approach produces its best results when relationships remain stable, an invalid assumption for high technology.

First, high technology industries are dynamic. Rapid growth is often the rule, not the exception. Technological innovation leads to new products and can change extensively how established products are made. In doing so, it alters the technical skills needed for its support. Additionally, it is difficult to forecast growth based on traditional skill categories when technology redefines those categories. For example, linotype operators were a relevant skill category when linotype machines were used to produce newspapers; when newspapers converted to new computer-based composing systems, a new set of skills was needed.

Also, Georgia's economic profile is subject to change. The acquisition of a major weapons system contract by a Georgia-based defense contractor or the establishment of a high technology production facility can dramatically increase needs for specific types of technicians. Changes in the rates at which traditional industries incorporate new technologies can markedly affect the number and type of skilled technicians needed by those industries. Thus, extrapolations based on past employment patterns or economic profiles are inherently risky. Finally, the validity of the traditional approach to estimating the need for technicians depends on detailed and timely data. Much of the data available on Georgia employment is from 1975. Given the rapid changes characteristic of high technology industries, this data was judged obsolete and therefore was rejected.

Instead, a two-part methodology was devised to estimate future employment. This methodology distinguished between industries for which recent Bureau of Labor Statistics (BLS) forecasts were available and industries for which such projections had not been attempted. For industries for which the BLS had developed recent measurements of current employment and forecasts after 1990, the following steps were taken:

First, since Georgia represents 2% of the national population, Georgia's portion of current employment was *a priori* assumed to be 2% of the national figure. For example, if the national figure for a particular skill area was 100,000, then Georgia's share was assumed to be 2,000.

Second, projected national employment past 1990 was similarly determined. If, for example, employment in a given technology was forecast to increase nationally from 100,000 in 1980 to 150,000 in 1990, then Georgia's 2% share would be expected to increase from 2,000 to 3,000.

Third, on the basis of information gained from a thorough literature review and through contacts with knowledgeable persons, qualitative judgments were made about the likelihood that the growth rate in Georgia would be less than, equal to, or greater than the national rate. Adjustments were made to the data to reflect these judgments. For example, if in a particular skill area several new firms had recently set up operations in the state, adjustments would be made to reflect this increased level of activity.

In those areas where Bureau of Labor Statistics data and projections were unavailable, a more elaborate approach was followed:

First, through a comprehensive literature review three scenarios were developed for each high technology area: low, most likely, and high. A number of sales forecasts in a particular high technology area would be collected. These would be grouped into low, most likely, and high growth rates for sales in that area.

Second, a small number of firms were chosen to represent that technology area. A combined productivity index would be calculated for these firms reflecting sales per production employee. Production employees were assumed to be 70% of total employment--a figure roughly equivalent to the relationship of production employment to total employment in U.S. manufacturing (See Appendix B). Current sales would be divided by the number of production employees to determine sales per production employee. For example, if a firm had 10,000 employees, 70% or 7,000 would be judged to be production employees. If sales were $560 million, sales per production worker would be $80,000 for the representative firm.

Third, the forecast sales for the entire industry were divided by the representative sales per production worker figure to estimate employment. For example, if total industry sales were forecast to be $80 billion in 1990 and the average sales per production employee were $80,000 then total employment in the U.S. would be one million employees in 1990.

Fourth, given that Georgia's population represents approximately 2% of the U.S. population and assuming that employment in this skill category was equally distributed, Georgia's potential share would be 2% (20,000 production employees in 1990 in the example above).

Fifth, utilizing an extensive literature review supplemented by discussions with persons knowledgeable about industry and employment trends in Georgia, qualitative estimates were made about whether Georgia initially had less than 2%, 2%, or greater than 2% of the workers and whether growth in this industry would be equal to, less than, or more than the national rate. This revised percentage was then applied to the total calculated U.S. employment for a given industry category.

This two-part methodology does have certain weaknesses. The best sales estimates, especially for technology-based industry, can have a large margin of error. Experts can be wrong; fundamental conditions change, causing shifts in the relationships on which estimates are based. Changes in the rate at which Georgia's economy grows can have a major impact on the number of skilled workers needed.

However, this two-part methodology has several advantages over the traditional extrapolation method. First, the data on high technology industry trends that were utilized are current. Second, data from a number of different sources were incorporated. Third, informed opinions were combined with the estimates of sales growth.

D. EMPLOYMENT PROJECTIONS

After a careful review of the literature and discussions with persons knowledgeable in industrial trends in the U.S. and Georgia, seven areas of high technology were chosen as having the greatest potential for growth in Georgia. These technology areas are:

1. Computer Services
2. Computer Manufacturing
3. Communications
4. Avionics
5. Laser Technology
6. Biotechnology
7. Solar Energy

In the following subsections, estimates have been developed for each of these technology areas. Three time periods have been utilized: 1980-1985, 1985-1990, and 1990-2000. Under each area of technology, a definition and a short market analysis are given as well as national sales and job projections, trends in Georgia, and the number of jobs projected in Georgia. In addition, national and statewide impacts of industrial automation are discussed in general terms. A summary is given in Table 2-1.

1. Computer Services

a. Definition - Computer Services

The computer service industry can be divided into the following three segments: processing services, professional services, and software products. Companies involved in processing services offer access to those services through a large computer facility on which small customers can perform such tasks as batch processing, remote problem-solving, remote transaction processing, and remote data inquiry.

Table 2-1

ANTICIPATED EMPLOYMENT INCREASES

	INDUSTRY	SALES INCREASE ($ BILLIONS)	NEW NATIONAL EMPLOYMENT	NEW GEORGIA EMPLOYMENT	ANNUALIZED NEW GEORGIA EMPLOYMENT
1980-1985	Computer Services	NA	461,000	14,500	2,900
	Computer Manufacturing	$ 30.0	431,000	6,500	1,290
	Communications	$ 17.6	258,000	7,700	1,530
	Avionics	$ 5.9	110,000	3,300	660
	Laser Technology	$ 2.6	30,000	600	120
	Biotechnology	$ 2.8	32,000	300	60
	Solar Energy	$ 0.3	3,000	-----	-----
		$ 59.2	1,325,000	32,900	6,560
1985-1990	Computer Services	NA	461,000	14,500	2,900
	Computer Manufacturing	$ 35.0	486,000	7,200	1,440
	Communications	$ 32.4	476,000	14,300	2,860
	Avionics	$ 7.9	147,000	4,400	880
	Laser Technology	$ 5.3	61,000	1,200	240
	Biotechnology	$ 5.6	65,000	600	130
	Solar Energy	$ 0.6	7,000	70	10
		$ 86.8	1,703,000	42,270	8,460
1990-2000	Computer Services	NA	461,000	29,000	2,900
	Computer Manufacturing	$ 47.0	652,000	9,800	980
	Communications	$137.0	2,000,000	59,500	5,950
	Avionics	$ 25.0	468,000	14,000	1,400
	Laser Technology	$ 27.0	313,000	6,200	620
	Biotechnology	$ 16.0	184,000	1,800	180
	Solar Energy	$ 4.0	38,000	400	40
		$256.0	4,116,000	120,700	12,070

NOTES: 1) Employment numbers represent producers of high technology (except Computer Services)
2) Numbers may not add due to rounding

Professional services offer turnkey computer systems, programming for specialized tasks, and the management of data processing facilities. This segment is very personnel-intensive and, of the three, is the most subject to shortages of skilled workers.

Software products consist primarily of instructions that guide computer equipment through its tasks. A chronic shortage of qualified computer programmers and systems analysts has already affected the development of software for new computer applications.

b. Market Analysis - Computer Services

The International Data Corporation (IDC), a leading consulting firm in the industry, estimates that the computer service market will expand at a rate of about 19% annually, reaching $35 billion in sales by 1985. At this pace, the value of computer services (excluding those made by hardware manufacturers like IBM) should exceed that of computer hardware shipments by 1984.

Demand is being fueled by the decline in hardware prices, growing user sophistication, productivity improvement efforts, and a shortage of qualified customer-employed programmers. Contributing to this growth is the increasing number of installed computers.

IDC estimates growth for the processing service segment to be 16% through 1985. Growth in professional services is projected at about 17% annually from 1980 to 1985. IDC projects that the small but growing software products segment will increase 27% annually over the years from 1980 to 1985, accounting for 25% of all computer service revenues by 1985.

c. National Employment Projections - Computer Services

The Bureau of Labor Statistics (BLS) has projected national employment trends to 1990. This direct forecast obviates the need for a sales forecast for this sector. The BLS's projected annual openings are expected to hold constant to the year 2000 (a rather conservative scenario). It will be noted that the number of jobs for keypunch operators will decline reflecting the replacement of keypunching entry with direct data entry systems.

The BLS predicted the following average annual job openings:

Systems Analysts	21,100
Programmers	25,200
Computer Operators	46,200
Keypunch Operators	(9,000)
Service Technicians	8,800
TOTAL	92,300

d. Trends in Georgia - Computer Services

Georgia is in an excellent position to take advantage of employment growth in this industry. Atlanta has a solid base of computer service firms, including Management Sciences of America (MSA), the largest computer service firm in the nation. Its Peachtree Software division recently obtained the rights to develop software for IBM's new personal computer.

e. Jobs in Georgia - Computer Services

Georgia is ahead of national trends in the computer service industry. Evidence suggests that the current industry base provides outstanding opportunities for future growth. Therefore, Georgia's employment growth is projected at 3% of the national job openings. Computer operators provide the highest growth in numbers, while service technician jobs are expected to grow the fastest (BLS study). Below are annual job projections in Georgia at 3% of the national growth:

Systems Analysts	630
Programmers	750
Computer Operators	1,380
Keypunch Operators	(120)
Service Technicians	260
TOTAL	2,900

2. Computer Manufacturing

a. Definition - Computer Manufacturing

The computer industry, as defined here, includes mainframe, mini-and microcomputers, peripheral computer equipment, and copiers. This compilation includes the major elements of the "office of the future," except for communications products, which are included in a later category.

Computer hardware can be divided by size and power. Mainframe computers can be characterized by IBM's large systems, which control 60% of this market. Minicomputers are much smaller than mainframe computers and are used in applications where the computing power of a mainframe computer is not required, offering cost and size advantages to the user.

Microcomputers refer to desktop machines with significantly less computing power than the mini's. The Apple computer is a typical microcomputer. Peripheral equipment refers to the disk memories, tape drives, video display terminals, and printers that are purchased to complement the central computer.

The bulk of copier sales are in plain paper copiers (PPC's); therefore copier sales and projections focus on this market.

b. Market Analysis - Computer Manufacturing

Over the past 30 years, computer technology has advanced exponentially; and rapid technological progress is expected to continue over the next decade. This growth will affect the types of computers available, computer applications, and the number and nature of computer occupations. Recent advances in semiconductor technology have resulted in the development of smaller computer components with greater memory and functional capabilities than had been previously available.

The key factor revolutionizing the use of computers has been the technical improvement of semiconductors allowing complex processing functions to be contained on a single chip. A complete microcomputer, with processor, memory, and input-output circuitry, can now be built on a single chip. Emerging microelectronic technology indicates a bright future for the computer industry.

Corporations such as Hewlett-Packard and Intel have recently presented papers on the latest generation of computers on single chips. Intel calls its creation a micro-mainframe because it has the performance of a large machine at the cost of a microcomputer. The micro-mainframe helps to solve current technological computer problems in at least two ways. It provides processing power which heretofore was limited to mainframe and top end minicomputers, and the software architecture provides high level programming capabilities. This new technology forms the basis of a new generation of computers.

The computer industry is expected to show steady growth through the 1980's, with most rapid expansion likely to occur in the market for smaller systems. Microcomputers, the smallest of the processors, make up the most dynamic computer market. Among the peripheral markets, graphics terminals are likely to enjoy superior growth rates in the 1980's. With the ability to display diagrams and graphs as well as alphanumeric characters, graphic terminals have found major applications in CAD/CAM (computer-aided design and computer-aided manufacturing) markets.

According to Business Week, the 1980's are the decade of the automated office system. Paper pushing will be largely replaced by information displayed on computer terminals, filed in computer memories, and shared among office machines that "talk" to each other. According to Business Week, the major participants in the competitive race to provide the complete "office of the future" are Xerox, IBM, Wang Laboratories, Digitial Equipment Corporation (DEC), Datapoint (Lanier Business Products), and several Japanese firms.

c. Sales Projections - Computer Manufacturing

National sales projections are based on Standard and Poor's Industry Survey for the computer industry. Each market segment has different projected growth rates. Microcomputer sales are estimated to grow at over 50% per year, while the value growth of mainframe computers is estimated to be less than 6%. The weighted composite growth rate for the industry is 13%. This has been adopted as the "most likely" forecast for growth in sales. Control Engineering quoted a five-year 18% growth rate, which is our "high" prediction. Few analysts at Standard and Poor's expect this explosive industry to grow at less than 10%; thus, this figure represents the "low" estimate. Any bias among these three scenarios favors the conservative predictions.

Standard and Poor's had forecasted explosive growth for the office automation industry. Plain paper copiers are expected to grow 16.7% over the next five years. This forecast is extended at 10% from 1985 to 1990 and at 7.5% from 1990 to 2000. "Intelligent" copier sales are expected to grow from $400,000 to $1 million by 1985. This forecast is extended at 20% annual growth from 1985 to 1990 and 7.5% annual growth from 1990 to 2000. As defined, office automation equipment will represent a $48 billion market by 2000.

d. National Job Projections - Computer Manufacturing

Sales output per worker was calculated from companies that represented industry averages for each market segment: IBM (mainframe), Cray

Research ("super"), and Commodore International (microcomputer). (Peripheral markets are too fragmented to justify inclusion.) These representative companies yield a weighted composite output of $72,000 per production worker. This figure was then divided into national projected sales increases to determine the number of new manufacturing employees required to reach those sales levels. The "most likely" estimate for 1980-1985 was 67,200 new manufacturing employees per year. Unfortunately, new computer manufacturing facilities have recently located or are concentrated in states such as Texas, California, and Massachusetts enabling these states to reap the benefits of this new employment.

Xerox is the leader in office copiers with a production output of $84,000 per production worker. Copier and printer production should require another 19,000 new manufacturing employees per year.

e. Trends in Georgia - Computer Manufacturing

Georgia has historically been slightly behind national employment trends in the computer industry. Georgia does have one of the major word processor manufacturers, Lanier Business Products, and two important color graphic computer companies, Intelligent Systems and Chromatics.

The Georgia state government is pursuing the electronics industry, and Georgia should attract some large semiconductor manufacturing plants because of favorable labor conditions. Atlanta is an important transportation center and provides rapid movement for the small electronic components required in this industry. Because of these industrial and technological trends, Georgia is seen as growing in computer manufacturing employment, but at a rate slightly below the national surge.

f. Jobs in Georgia - Computer Manufacturing

Given the historical data and these qualitative weightings, Georgia's "most likely" computer employment growth is projected at 1.5% of the national growth. Approximately 1,290 new production workers will be needed in this industry every year between 1980 and 1985. The annual demand should rise to approximately 1,440 new production workers between 1985 and 1990, and approximately 980 new openings between 1990 and 2000.

3. Communications

a. Definition - Communications

Communications includes satellites; terrestrial services such as cable television, telecommunications, teleconferencing, and electronic mail; and related fiber optic technology (included in this section because of its central place in communications).

Fiber optics transmission systems are relatively new technologies that enhance the information-carrying capacity of both long and short range communications networks. These systems use modulated light sources to transmit digital information along fine fibers of optical material.

b. Market Analysis - Communications

Many corporations have found that by combining recent advances in communications technology with the capabilities of modern computers and word processors, they can develop systems like "electronic mail" and the "electronic office." Messages and mail are sent by computer or word processing terminals without generating hard or paper copies, avoiding the delays that sometimes arise with the U.S. mail and intraoffice communications. The next step in this process is tying satellites into the local communications network. A limited number of corporations have already done this.

Fiber optic transmission offers numerous advantages over wire systems, such as larger bandwidths, lighter weight, smaller diameter, more freedom from "crosstalk," and significantly lower costs. According to

Electronics Market Trends, telecommunications is the largest and fastest-growing market for fiber optics.

c. Sales Projections - Communications

IBM, with an important stake in the communications market, has forecast an 8.3% sales growth for this sector from 1980 to 1985 and a 15% sales growth from 1985 to 1990. The latter part of this decade should witness the growing importance of business satellites and massive communications networking. Utilizing IBM's estimates of 8.3% and 15% growth yields, sales increases of $17.6 billion between 1980 and 1985 and $32.4 billion between 1985 and 1990 are forecasted.

d. National Job Projections - Communications

Scientific Atlanta, the leader in satellite communications, and Teleprompter, the leader in cable television, are used to represent industry sales output per worker at $69,000. National projected sales increases indicate that over 51,600 workers will be needed annually for the total communications market (telecommunications, cable television, satellite communications, and fiber optics production) between 1980 and 1985. The industry is forecasted to burgeon extraordinarily, requiring over 95,000 production workers nationally between 1985 and 1990.

e. Trends in Georgia - Communications

Communications is Georgia's largest high technology employer. Georgia can boast of advanced communications at Scientific Atlanta (satellite and cable TV equipment), Western Electric Atlanta Works (fiber optics production), Turner Broadcasting Network (cable TV), and Continental Telephone (total communications network), among others. Thus, Georgia should capture more than its proportionate share of new employment in communications.

f. Jobs in Georgia - Communications

Historical employment growth, the current manufacturing base, and technological trends all point to tremendous potential for communications in Georgia. Therefore, the "most likely" estimate was set at 3% of national employment growth. This translates into 1,530 average annual job openings between 1980 and 1985; 2,860 per year between 1985 and 1990; and 5,950 annually between 1990 and 2000.

4. Avionics

a. Definition - Avionics

The word "avionics" is a hybrid formed from the combination of "aviation" and "electronics." Avionics is the science and technology of the use of electrical and electronic devices in aviation. This technology includes guidance logic, electronic warfare, electronic aids to navigation, takeoff-and-landing instrumentation, and surveillance.

b. Market Analysis - Avionics

A very large part of the military electronics market is comprised of avionics equipment. In the rapidly expanding, technologically advanced area of electronic warfare (which also includes intelligence and surveillance equipment), the latest developments in semiconductor technology are employed. For example, the most advanced electronic countermeasure (ECM) system being developed is the Airborne Self-Projection Jammer, or ASPJ. The ASPJ will rely on programmable microprocessors which enable a pilot to program available countermeasures to meet the threat from both air-to-air and surface-to-air missiles.

In commercial avionics a gradual shift to digital technology is taking place. Digital technology development is underway on Boeing's new generation 757 and 767 aircraft. The 747 may also undergo digital equipment retrofitting. Basic elements of a digital system on such a plane as the 767 would include autopilot, autothrottle, electronic displays, flight management computer, thrust management system, engine electronics, sensors, air data computer, control heads, and digital bases.

c. Sales Projections - Avionics

According to Standard and Poor's analysts, total avionics sales should grow $5.9 billion over the period 1980-1985. Growth for this sector should exceed $7.9 billion for 1985-1990 (combining Standard and Poor's estimates with those of the Electronic Industries Association). These same growth rates projected to the year 2000 predict annual sales growth at $2.5 billion for each year between 1990 and 2000.

d. National Job Projections - Avionics

Sales output per worker was calculated from E-Systems, Inc., a medium-sized avionics firm, at $53,600. National average annual openings should be approximately 22,000 between 1980 and 1985; 29,400 between 1985 and 1990; and 46,800 between 1990 and 2000.

e. Trends in Georgia - Avionics

Georgia has an excellent manufacturing base in avionics and should prosper from military spending over the next 20 years. Loral, Marconi, Rockwell International, and Lockheed--whose loss on the C5B may be temporary--are all active in avionics employment. Georgia's military bases and commercial airlines also provide nearby users with avionics equipment.

f. Jobs in Georgia - Avionics

Rockwell International's decision to build missile guidance systems in Georgia is a pertinent example of the state's potential for new avionics employment. If Georgia captures 3% of the national avionics market (viewed as "most likely"), then 660 production workers will be needed annually between 1980 and 1985; 880 production workers annually between 1985 and 1990; and over 1,400 production workers annually between 1990 and 2000.

5. Laser Technology

a. Definition - Laser Technology

The laser is an electronic device that emits an extremely intense beam of energy in the form of light rays. The laser's high intensity and single color provide significant advantages for such scientific fields as nonlinear optics, plasma diagnostics, spectroscopy, meteorology, seismology, solar stimulation, and certain types of photography. Laser light beams can be applied in surveying, building, ship navigation, and in space vehicle guidance and tracking systems.

Five important types of lasers are in current use, each requiring slightly different technical expertise. Optically pumped solid state lasers use the presence of suitable impurities, like chromium and aluminum oxide, to create the streams of light. These lasers are best suited to applications requiring brief, very high powered pulses of laser light. On the other hand, gas lasers produce highly coherent light beams and are considerably better than solid state lasers for longer duration uses. These lasers are used primarily for cutting and welding applications.

Chemical lasers are valuable in remote sites where electrical power is scarce (for example, space vehicles). The most important example of this type is the hydrogen fluoride laser, capable of generating light pulses of very large energy from relatively modest equipment. Semiconductor lasers are highly efficient, making them valuable in communications applications. Many liquid organic dyes will lase when pumped with ultraviolet light. Two important properties of dye lasers are tunability--that is, the ability to vary the emission and short pulse capability--and the ability to generate light pulses whose duration can be less than a trillionth of a second.

b. Market Analysis - Laser Technology

Lasers promise to promote the growth of several fields of physics (primarily optics), photography, communication, ranging, surveying, nuclear fusion, medicine, chemistry, and the fabrication of metals and ceramics. One of the most dramatic uses of the laser is in medicine where it is used to treat retinal detachments.

Solid state lasers and gas lasers are currently the most important in terms of sales and are predicted to increase threefold in production from 1980 to 1985. Solid state lasers alone are predicted to represent a $440 million market by 1985. The total laser market is predicted to increase to over $2.6 billion by 1985. Military applications currently account for 50% of the laser market; however, commercial applications are growing at 35% annually and will overtake military expenditures by the year 1985 (Laser Focus).

c. Sales Projections - Laser Technology

Lasers have commercial, industrial, and military applications. Several examples are shown in Table 2-2. Markets for lasers are growing rapidly. Laser Focus projects 28% sales growth rates over the years 1985 to 1990. As the market increases over the $10 billion level, growth rates should slow to 15%, a figure which still represents robust growth, to the year 2000.

d. National Job Projections - Laser Technology

Sales output per production worker was calculated at $86,500 from Spectra-Physics, the largest commercial manufacturer of lasers. According to national sales projections and this given productivity rate, 30,000 laser technology workers will be needed between 1980 and 1985; 61,000 between 1985 and 1990; and 313,000 between 1990 and 2000. This calls for annual openings of 6,000 (1980-1985); 12,000 (1985-1990); and 31,000 (1990-2000) for the nation.

TABLE 2-2

MAJOR APPLICATION OF LASERS FOR
INDUSTRIAL PROCESSES AND ENERGY GENERATION

Application	Commercial Application Now	Commercial Application in 1989	Growth Rate	Notes
Metal Hardening Welding	Yes	Yes	Steady	Well established -largest industrial laser applications today
Cutting and Drilling	Yes	Yes	Strong	
Material Removal	Yes	Yes	Modest	Limited potential
Marking and Engraving	Yes	Yes	Fast	Heavy use for noncontact marking of small parts
Semiconductor Annealing	Yes	Yes	Very Fast	Vital for increasing number of parts in semiconductor manufacturing
Isotope Separation	Limited	Yes	Strong	Large payoffs in radioisotope production
Other Photochemical	Barely	Yes	Very Fast	Exciting possibilities
Nuclear Fusion	No	Unlikely	--	Look for possible sudden breakthrough

Source: "Lasers in Industry, Energy, and Photochemistry", International Resources Development, Inc., Norwalk, Conn.: IRD, 1979.

e. Trends in Georgia - Laser Technology

Georgia is strong in laser research. The Georgia Institute of Technology is a major center of defense-related laser research. In addition, Georgia is home to several firms and military bases utilizing laser technology in defense applications. However, the state is weak in commercial laser applications. Industrial lasers are finding quicker acceptance in states with more extensive heavy manufacturing. Nevertheless, Georgia has potential for employment in this sector, particularly with its strong defense industry. This sector should be watched closely for dramatic employment demands.

f. Jobs in Georgia - Laser Technology

Given Georgia's research and industrial base, its projected laser technology employment is set at 2% of the national growth. This implies that approximately 120 skilled workers will be needed annually between 1980 and 1985, 240 needed annually between 1985 and 1990, and 620 between 1990 and 2000.

6. Biotechnology

a. Definition - Biotechnology

Biotechnology, as defined here, includes genetic engineering, bioengineering (artificial body parts), and electronic medical equipment. Electronic medical equipment is included in this section because of its relation to the health field and its importance as a growth industry.

Genetic engineering is the technology of modifying organisms. The most dramatic and revolutionary technique is recombinant DNA technology, also known as gene splicing. Genetic engineering presents the scientific and industrial community with the potential for developing micro-organisms with improved properties and new applications. Bacteria can be synthetically manipulated to produce antibiotics, interferon, hormones, vaccines, and insulin.

Artificial body parts are a small but important new field of biotechnology. An artificial heart has been successfully tested in calves, and it is predicted that humans will be able to use this type of artificial device by 1990. Significant progress has been made in enabling artificial limbs to respond to brain signals. Other artificial organs are being improved dramatically by advanced technology.

Electronic medical equipment refers to new medical technologies designed to increase physicians' ability to make early and accurate diagnoses. Fiber optics, nuclear imaging, and sensitive tests for the biochemical analysis of body tissues and fluids are invaluable for diagnosing disease. Perhaps the most conspicuous among the new diagnostic tools is the computerized axial tomography known as the CAT scanner. CAT scanning makes it possible to "see" into the brain and into other recesses of the body. Ultrasound techniques are another growing diagnostic technique.

b. Market Analysis - Biotechnology

According to Venture magazine, over 40 new genetic engineering companies have been formed since 1978. Their fields of interest include medical, agricultural, energy, and industrial products and processes. A support industry for genetic engineering has also been established to meet growing material, equipment, and information needs. One of the more important products in the support industry is synthesizing equipment which tailors DNA to biological specifications.

The first commercial use of genetic engineering will be an ethanol plant scheduled to start up in early 1983. In that year the Cetus Corporation plans to use its improved strains of yeast to increase the efficiency of a new continuous fermentation process. Genentech, another leading firm in genetic engineering, expects to place synthetic human insulin on the market in 1983 and both human growth hormone and interferon by 1985.

Artificial body parts production is progressing steadily, but advances in the area are naturally slowed by the extensive testing that must precede the mass introduction of new discoveries. As mentioned before, significant progress is being made in the development of artificial organs and limbs.

Many advanced products are on the horizon in medical electronics. A body-imaging technique more powerful than the CAT scanner is now in the testing stages. Called "nuclear magnetic resonance" (NMR) tomography, this system generates pictures of both whole-body and single-organ cross sections in ten minutes or less. This machine can locate an artery in the brain, measure its blood flow, and determine whether the oxygen consumption of the right hemisphere is adequate. Another important product is a new generation X-ray machine which allows physicians to obtain color television pictures of most organs in the body.

New machines for detecting cancer in earlier, more controllable stages are considered a new hope for the 1980's, according to Dunn's Review.

c. Sales Projections - Biotechnology

Sales for the three components of the biotechnology sector are predicted to show a $2.8 billion increase from 1980 to 1985 (Predicasts, Inc.). Electronic medical equipment sales will account for most of this growth. From 1985 to 1990, sales should jump another $5.6 billion according to International Resources Development, Inc., a market research firm. From 1990 to 2000 genetic engineering is expected to contribute $7.2 billion in sales, according to a study done by the U.S. Office of Technology Assessment (Impacts of Applied Genetics: Micro-Organisms, Plants and Animals, April 1981).

d. National Job Projections - Biotechnology

Abbott Laboratories is a leader in electronic medical equipment and provides the best industry average for the next 10 years because other genetic engineering firms are too young to use for projection purposes. Abbott's output per technical worker is approximately $85,700. National projections are for 6,400 annual openings between 1980 and 1985; 13,100 annual openings between 1985-1990; and 18,400 annual openings between 1990 and 2000.

e. Trends in Georgia - Biotechnology

Georgia does not have a current manufacturing base for either recombinant DNA products or medical electronic equipment. Although both Emory University and the University of Georgia are pursuing research in genetic engineering, this research has not yet resulted in the development of private sector firms in Georgia.

f. Jobs in Georgia - Biotechnology

It is estimated from the current manufacturing base that biotechnology will employ few technical production workers in Georgia relative to national trends. "Most likely" estimates were projected at 1% of national employment growth. This translates into 60 openings per year from 1980 to 1985; 130 openings per year from 1985 to 1990; and 180 annual openings from 1990 to 2000.

7. Solar Energy

a. Definition - Solar Energy

There are two principal techniques, photovoltaic and solar thermal, by which radiant energy from the sun may be collected, converted, stored, and used in a wide variety of practical applications.

Photovoltaic cells, which produce electric currents when sunlight impinges on them, are not extensively used at present due to their high cost. However, solar cells are attractive for a number of reasons: they are quiet, non-polluting, consume no water, have a long potential life, and require little maintenance. Although some cost reductions have been effected, further reductions are needed before widespread adoption of this technology can be assured.

Solar thermal technologies may be categorized as passive, active, or hybrid. A passive system consumes no non-solar energy in its operation. The majority of passive solar applications are for space conditioning (heating, cooling, ventilation) and water heating systems. Active solar thermal systems employ non-solar energy to drive pumps or fans to transfer energy from a collector to a storage system or to the point of use. The energy available is limited by the size and type of collector as well as the intensity of solar radiation. Common uses for active thermal systems are space heating, water heating, and commercial/industrial processes including the generation of electricity and steam. Hybrid solar energy systems are a mix between active and passive systems. The term is generally applied to systems which are primarily passive with minor non-solar energy consumption for such functions as relocating shades or insulation as the solar conditions change.

b. Market Analysis - Solar Energy

Passive solar systems for heating and cooling are now in use throughout the United States, encouraged by individual tax credits. Their use is likely to become more widespread as older buildings are replaced and mass production reduces the price of available passive solar systems. The most immediately promising solar application is the production of low temperature heat for hot water to serve a variety of commercial, agricultural, and industrial purposes.

The federal solar budget for all kinds of solar research increased from \$2 million in 1972 to nearly \$1 billion for fiscal year 1981. However, recent cutbacks in federal support for solar research have reduced the rate of development and attractiveness of active solar systems, impacting negatively on employment needs in both active and passive solar energy. A small group of companies, including Texas Instruments, continues to make a substantial investment in solar cell research, and a small, highly competitive U.S. industry has sprung up to supply photovoltaic systems for the world market (which is healthier than the U.S. market at this time).

c. Sales Projections - Solar Energy

According to local industry analyst Bill Schwendler, President of the Solar Energy Industries Association of Georgia, Inc., the total solar energy industry will most likely grow by 15% until 1990. For the period from 1980 to 1985 this means a national sales increase of only $301 million. Sales increases should jump to $634 million for the period from 1985 to 1990. Assuming that energy prices rise, Schwendler sees 20% growth from 1990 to 2000. This represents sales growth of over $3.8 billion for the ten-year period.

d. National Job Projections - Solar Energy

Sales output per worker was calculated separately for photovoltaic and solar thermal segments. Ametek is a leader in the photovoltaic industry; output per production worker is $77,000. Solomon, one of the leaders in solar thermal energy, has an output per production worker of $108,000. Therefore, national annual openings are projected at just over 600 for 1980-1985; just over 1,300 annually for 1985-1990; and 3,800 annually for 1990-2000.

e. Trends in Georgia - Solar Energy

There are more impediments than spurs to the growth of solar technology in Georgia. Although Georgia has a good climate for collecting solar energy, the state's relative energy costs are much lower than most other states and cause solar energy to be economically unfeasible at this time.

High initial solar costs, high interest rates, and few tax incentives have also slowed the growth of solar energy in Georgia, although significant breakthroughs in technology could reverse this trend.

f. Jobs in Georgia - Solar Energy

Solar energy is expected to demand the fewest new jobs among the technological areas discussed in this report. Employment growth is estimated at 1% of the national growth until 1990. It is expected that eventual tax incentives will push growth to 1.5% of the national figure. Less than 40 annual openings are forecasted in this area to the year 2000.

8. Projected National and Statewide Impacts of Industrial Automation

a. National Impact

The impact expected from the manufacture of high technology products has been discussed; however, vocational-technical schools may experience more direct impacts from users of high technology applications. U.S. manufacturers are using more and more sophisticated machines and processes as they strive to increase productivity and to remain competitive in the international marketplace. The applications of these technologies will influence the operations of a number of industries.

The growth of digital electronics and the explosive advance of semiconductor technology have ushered in a new era of progress in industrial control concepts and applications. The minicomputer has advanced the concept of decentralized control and has led to extremely rapid growth in plant automation. Computerized industrial control has proven most successful in the energy-intensive process industries--steel, aluminum, petroleum, chemical, food, textile, and pulp and paper. Major new advances in automation center on second generation robots, microprocessor-controlled ultrasonic instrumentation for nondestructive testing, and improved laser systems for better machining results.

The extent to which manufacturing processes will be automated within the next two decades is very difficult, if not impossible, to quantify. However, all authorities agree that the effect of automation will be a major one. According to a recent study by Carnegie-Mellon University, almost 7 million manufacturing employees will be affected by automation during this period (Table 2-3). Existing and anticipated advances in electronic industrial systems and manufacturing techniques will affect almost 13% of the work force by the year 2000. If the impact these advances will have on the office work force is included, almost 45%, or 45 million jobs, will be affected during the same period.

Industrial robots are an innovation that is beginning to have a dramatic impact on U.S. manufacturing. These programmed mechanical arms and other devices are being used in a variety of applications that relieve production workers of repetitive and often dangerous tasks in a diverse group of industries. For example, a robot-controlled laser beam cuts out sheets of graphite for the brake assemblies in jet aircraft at McDonnell Douglas in St. Louis. Mechanical arms are being used to box jars of lotion at manufacturing facilities in Clinton, N.Y., and robots are being used by textile firms in Georgia and throughout the Southeast. Examples of the tasks performed by robots in the automobile industry are shown in Table 2-4. Current estimates indicate that 3,000 or more robots are in operation in the United States, with about 500 of these being used by the automobile industry.

The Robotics Institute of the Society for Manufacturing Engineers estimates that there will be 15,000 robots in use in the U.S. in 1985 and between 75,000 and 100,000 by 1990. Officials of Cincinnati Milacron and the Robotics Institute estimate that presently one technician is needed per five robots in service. Based on these estimates, 3,000 technicians would be needed nationally to service robots by 1985 and between 15,000 and 20,000 would be needed by 1990.

TABLE 2-3

JOBS IN THE U.S.THAT WILL BE DIRECTLY
AFFECTED BY AUTOMATION
1980-2000

Industrial		Office	
Assemblers	1,289,000	Managers	9,000,000
Checkers, Examiners, Inspectors, Testers	746,000	Secretaries and Support Workers	14,000,000
Production Painters	185,000	Clerks	5,000,000
Welders, Flame Cutters	713,000	Other Professionals	10,000,000
Packagers	626,000	TOTAL	38,000,000
Machine Operatives	2,385,000		
Other Skilled Workers	1,043,000		
TOTAL	6,987,000		

Source: "The Impacts of Robotics on the Workforce and Workplace." School of Urban and Public Affairs, Department of Engineering and Public Policy (Carnegie Institute of Technology) Department of Humanities and Social Sciences, Pittsburgh, Pa.: Carnegie-Mellon University, 1981.

TABLE 2-4

FUNCTIONS OF ROBOTS ON THE AUTO ASSEMBLY LINE	
Spot Welding	Machine Tool Loading/Unloading
Pedestal Welding	Conveyor Transfer
Arc Welding	Palletizing
Stud Welding	Plastic Molding
Die Casting	Paint Spraying
Permanent Moldcasting	Adhesive Lay-up
Press Transfer	Foam Lay-up
Forging	Glass Handling
Heat Treatment	Dimensional Inspecting
Casting	

b. Georgia Impact

Georgia can expect to experience an impact from the use of automated technological applications in new and existing industries. The new Pratt & Whitney manufacturing facility now under construction in Columbus, Georgia, is an excellent example of the latest manufacturing technology and of future high technology manufacturing in Georgia. Larger numbers of computers and robots will be used in the manufacturing departments, making the new facility a world class showcase for the most modern manufacturing technology available.

This new facility, along with many future Georgia plants, will offer the most advanced manufacturing technology available and will be under computer control from the time raw material enters the production process through final inspection. Examples for anticipated computerized production elements were described by Pratt & Whitney's John Lyman in a recent talk:

o Material will travel by an automated system of unmanned vehicles, conveyors, and overhead monorails, following pre-established production schedules programmed within a central computer.

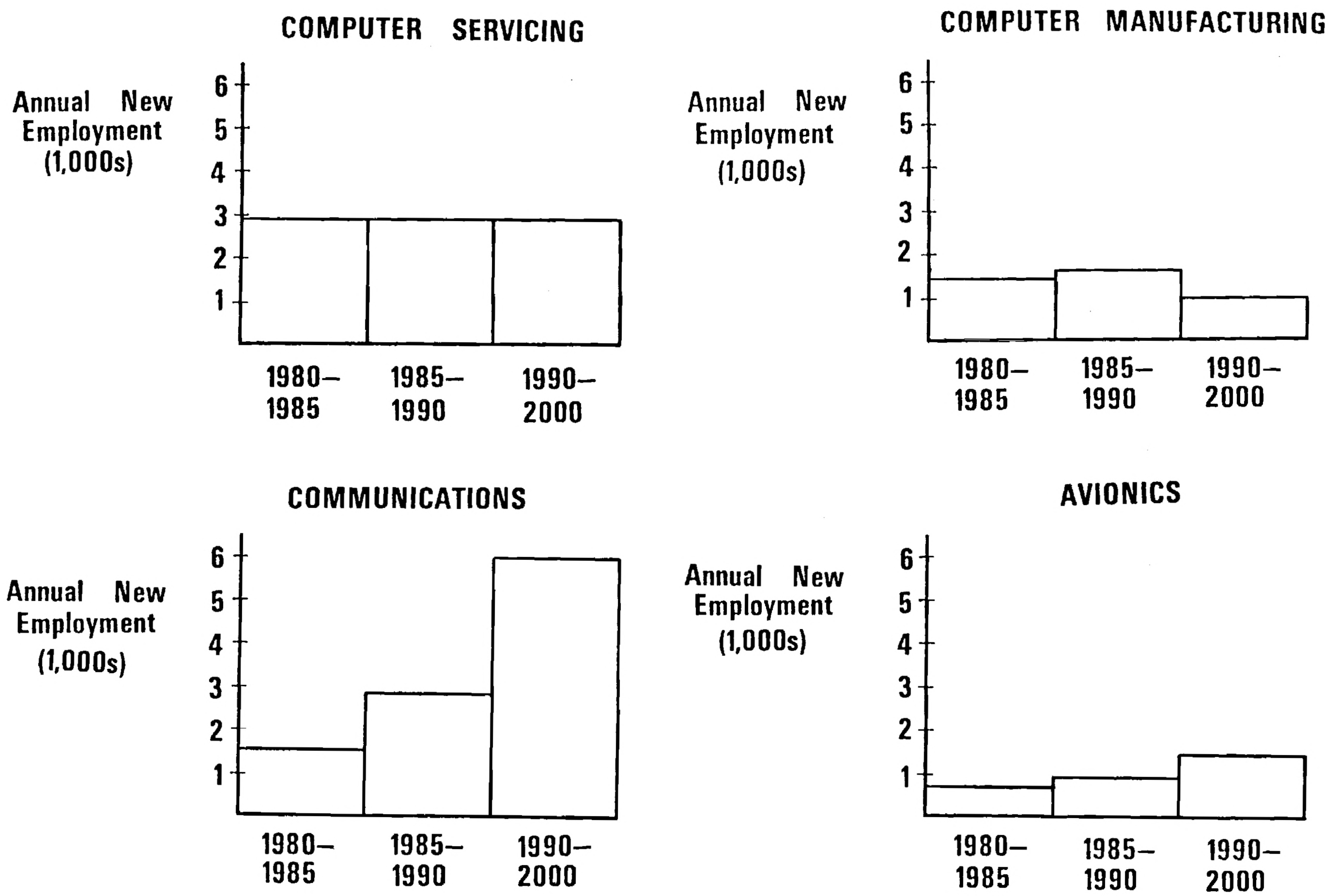
o The vehicles, about the size of golf carts, will be guided along cables embedded in the plant floor. Controlled by computers, they will be capable of carrying up to 6,000 pounds.

o In many of the manufacturing operations, material will be loaded automatically onto machines by a mechanism on the vehicles, reducing the time it takes to prepare for machining.

o About 50 robots also will be used to transfer materials from the conveyor system to cleansing tanks and to heat-treating furnaces. With a lifting capacity of up to 600 pounds, the robots will relieve employees of many strenous and repetitive operations.

FIGURE 2-1

ANTICIPATED ANNUAL NEW GEORGIA EMPLOYMENT BY AREA



The impact of the microprocessor and other manufacturing innovations will be generally felt throughout Georgia's traditional and emerging industries. Georgia's share of robot technicians alone will be 60 by 1985 and between 300 and 400 by 1990. New technological improvements in robotics, machining, electronics, and lasers will substantially change the face of American industry over the next 20 years; and Georgia's existing and future industries will be a part of this renovation.

E. IMPLICATIONS FOR TRAINING

Since well over 95% of the new production employment in Georgia is anticipated in Computer Services, Computer Manufacturing, Communications, and Avionics, they will be the focus of this section on training. The mix among the areas changes over time. In the 1980-1985 and 1985-1990 periods, Computer Services is expected to rank as the leading new employer. However, Communications is expected to rise rapidly and is predicted to take the top position in the 1990-2000 period. Note that Communications is anticipated to progress from third, to second, and then to first rank over the three periods. Also, note that Avionics is anticipated to rank fourth throughout the first decade and third in the next decade.

The rise of the four areas over the different periods is shown graphically in Figure 2-1. Computer Servicing is anticipated to remain constant over the three periods. Computer Manufacturing rises above, then falls below its initial level. Communications employment takes dramatic leaps, approximately doubling in each time period. Avionics increases more than 100% from 1980 to 2000, moving into third place by the 1990's.

It must be noted that the employment growth totals for these industries reflect the total production work force and not just the numbers of people likely to require technical training. However, according to information developed by the Bureau of Labor Statistics and outlined in the 1980-1981 Occupational Handbook, technicians in the electronics industry represent one of every twenty employees. Using this ratio of employment,

Table 2-5 projects the number of technicians that will be required by the Computer Services, Computer Manufacturing, Communiciations, and Avionics industries in Georgia.

Vo-tech schools cannot be expected to train all the required workers in the areas for which forecasts have been made. However, the vo-tech system must play a major role in preparing workers for the emerging areas of high technology. With the rather long advance notice given for expected areas of growth, a phase-in of training programs is suggested. Although only four areas have been emphasized here, that does not mean that the remaining four can be ignored. Decisions about Laser Technology, Biotechnology, Solar Energy, and Industrial Automation should be based on continual monitoring of developments in the area of high technology.

Industries representing high technology users and producers will soon place much greater demands on Georgia's industrial and public training capabilities. The ratio between parts-producing operators and technicians or indirect workers will change dramatically, increasing the number of people requiring advanced training.

The equipment in high technology manufacturing environments will be much more complex than the machines at work today. The technicians required to maintain and operate this equipment will need to command a variety of in-depth skills in such areas as hydraulics and electronics, as well as basic machining.

Computers will become more and more pervasive in all types of manufacturing, from individual programmable controls and microcomputers to linked banks of computers controlling many different machines. Increased levels of maintenance and attention from larger and more highly trained technician teams will be required.

As traditional industries upgrade their technology through installation of computer-driven process control and use of robotics, there will be a need

Table 2-5

REQUIRED PRODUCTION WORKERS AND TECHNICIANS IN GEORGIA
Annual New Employment

	1980-1985	1985-1990	1990-2000
Computer Services			
Production Workers	2,900	2,900	2,900
Technicians*	2,900	2,900	2,900
Computer Manufacturing			
Production Workers	1,290	1,440	980
Technicians	258	288	196
Communications			
Production Workers	1,530	2,860	5,950
Technicians	306	572	1,190
Avionics			
Production Workers	660	880	1,400
Technicians	132	176	280
TOTALS			
Production Workers	6,380	8,080	11,230
Technicians	3,596	3,936	4,566

* In this category, technicians are 100% of the production workers.

for new skills to support this effort. Some employment in these industries will not be expanding. This will most likely require the re-training of existing employees rather than the training of new entrants. For example, Mr. Roy Myers of Boeing in Macon, Georgia, states that the workers in shortest supply, as his company increases its use of computer numerically controlled metal-working machines, are experienced machinists with further training in programming. Similarly, in other areas of automation, traditional maintenance personnel will need to acquire diagnostic skills to identify problem areas and replace defective elements. As machine reliability increases and diagnostic capabilities are incorporated into the machinery, persons with traditional electrical skills may require upgrading to support increased process automation and robotics in traditional industries. Vocational education can support this re-training effort.

In the next decade, vocational education will face a formidable challenge. The training equipment will be more expensive, and the time and knowledge-level of instructors required for training will be much greater than previously necessary. The need for cooperation among public and private sector organizations to produce trained workers upon which Georgia's industrial future depends will be imperative.

SECTION III

AN INVESTIGATION OF HIGH TECHNOLOGY TRAINING NEEDS FROM AN INDUSTRIAL PERSPECTIVE

A. INTRODUCTION

Georgia Tech surveyed firms representing a broad spectrum of the high technology industrial sector in order to assess industrial training needs, particularly with regard to high technology, and how those training needs are currently being addressed. Representatives from both in- and out-of-state firms were interviewed to generate a comparison of industry perceptions toward vocational-technical training. Among the data collected was information on the use of vocational-technical school graduates, industry satisfaction with training results, perceived training deficiencies, and the extent of present industry/school interaction. These interviews were conducted with personnel familiar with industrial training needs such as training officers, personnel managers, and production managers.

B. SURVEY METHODOLOGY

Twenty high technology firms were selected for the survey, sixteen in Georgia and four out-of-state. Table 3-1 lists the types of high technology firms currently located in Georgia. The fields of computers, communications, and avionics are well represented, with lesser representation in robotics manufacturing and laser technology. Table 3-2 describes important aspects of the 20 companies interviewed in the survey. This table shows that the firms selected for the survey comprised a representative mix of:

- o High technology products
- o Size by employment
- o In-house training capabilities

TABLE 3-1

TYPES OF HIGH TECHNOLOGY FIRMS
CURRENTLY LOCATED IN GEORGIA

SIC CODE	TYPE OF PRODUCT	Number of Companies	Total Employed	Companies Not Reporting
3573	Electronic Computing Equipment	11	652	2
3613	Switchgear & Switchboard Apparatus	24	2,962	1
3622	Industrial Controls	8	1,578	-
3652	Computer Disks, Tapes	1	700	-
3661	Telephone & Telegraph Equipment	10	1,071	-
3662	Radio & TV Communications Equipment	19	1,651	1
3672	Cathode Ray Tubes	2	42	-
3674	Semiconductors & Related Devices	1	17	-
3675	Electronic Capacitors	4	752	-
3677	Electronic Coils & Transformers	4	374	-
3679	Electronic Components	17	1,392	1
3721	Aircraft	7	16,196	-
3728	Aircraft Parts & Auxiliary Equipment	8	881	-
3761	Guided Missiles & Space Vehicles	1	150	-
3764	Guided Missile Propulsion Units & Parts	1	17	-
3811	Engineering & Scientific Equipment	6	263	1
3822	Environmental Controls	2	199	-
3823	Process Control Instruments	4	198	-
3824	Totalizing Fluid Meters and Counting Devices	2	46	-
3825	Instruments to Measure Electricity	10	1,718	-
3829	Measuring & Controlling Devices	5	169	-
3841	Medical Electronic Devices	1	130	-
3861	3-D Photographic Systems	1	20	-
5081	Microprocessors	1	23	-
7372	Computer Programming & Software	11	709	-
7374	Data Processing Services	21	2,489	-
7379	Computer-related Services	12	895	-
7391	R & D Labs	4	365	-
8911	Robotics	2	20	-
	TOTAL	200	35,679	6

Note: This table does not include sales and maintenance companies.

Source: ATDC Update on High Technology Industries, May 16, 1982.

TABLE 3-2
OVERVIEW OF COMPANIES SURVEYED

Company	Computer Mfg/ Servicing	Communications	Avionics	Robotics & Automation	Laser Technology	SIZE			Hires Vo-Tech Graduates			In-House Training		Primary Designation	
						<100	100-1000	>1000	Yes	#	No	Yes	No	Prod	User
A	•						•		•	N/P		•			•
B	•		•					•	•	N/P		•		•	
C	•							•			•	•			•
D	•			•			•		•	15			•		•
E	•			•			•		•	4			•	•	
F	•			•			•				•		•		•
G	•						•		•	2		•		•	
H		•			•			•			•	•		•	
I	•	•	•					•	•	N/P		•		•	
J		•	•				•				•	•		•	
K	•						N/P		•	N/P			•		•
L	•						•		•	10		•			•
M	•					•			•	2-4		•			•
N	•					•					•	•			•
O	•		•	•				•	•	125		•			•
P	•		•	•				•	•	885		N/P			•
Q	•						•		•	5-6			•	•	
R				•			•		•	8-10			•	•	
S	•			•			N/P		•				•		•
T	•	•						•			•	•		•	

N/P Not Provided by Industry.

Geographical location was also considered. Atlanta is a transportation, communications, and education center, so many high technology firms are located in its metropolitan area. However, high technology firms are scattered throughout the state. No companies in the biotechnology and solar energy fields were surveyed because these areas are not yet well represented in Georgia.

Those companies surveyed were categorized as either primarily producing or using high technology products. Users were restricted to those companies requiring a significant skilled labor force both to operate and maintain the high technology components of their operations. Out-of-state companies were randomly selected to allow comparison with Georgia companies, particularly relating to interaction with vo-tech schools.

The method of data collection consisted primarily of personal interviews, although some telephone contact was made for follow-up questions. Interviews were unstructured and consisted of general discussions ranging over a number of issues. Interviewers used their own discretion concerning the timing and sequence of questions, allowing respondents to cover most aspects in their own style. This interview format allowed full interaction and encouraged remarks by respondents that had not been anticipated. This approach also permitted probing to clarify incomplete responses. Each company was guided to discuss:

- Company size (number of employees at that site)
- Number of job slots typically requiring vocational-technical school training or its equivalent
- Job titles and duties for these positions (copies of job descriptions were requested)
- Methods of recruitment
- Schools utilized, whether public or private
- Experience with vo-tech graduate workers
- Deficiencies in training found

- Experience with other training provided by the vo-tech system, particularly QUICKSTART programs
- Internal training programs and techniques utilized

Follow-up contacts largely consisted of requests for specific data, such as the numbers of technicians employed or copies of job descriptions which were unavailable at the time of the interview.

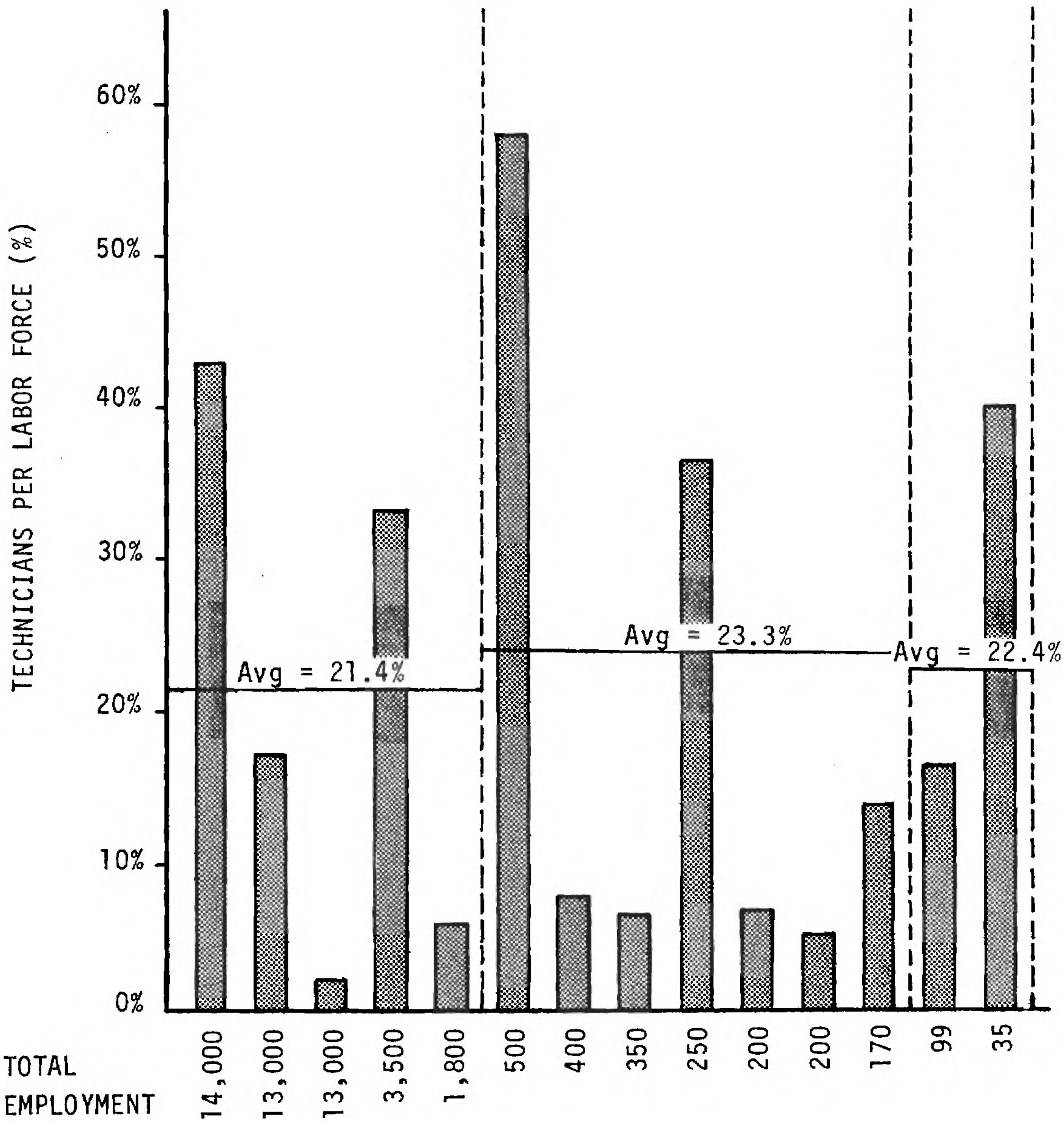
C. SURVEY RESULTS

As a first step in characterizing demand for technically trained personnel, firms were asked to identify their total labor force and the percentage of the work force requiring training of the caliber available in post-secondary vocational-technical schools. In addition, they were asked to identify the classification of jobs associated with the need for vo-tech training and to identify their employment breakdown as it related to these categories. This exercise was designed to help identify the skill groups which high technology firms require the vocational-technical schools to supply. It further helped to define the relative breakdown of demand by high technology category.

Figure 3-1 displays a comparison of total firm employment to the percentage identified as requiring vo-tech-type training for each of the 14 Georgia firms which provided such information. Individual company percentages range from 5% to 58%. One large firm training all its own technicians was excluded from the analysis. Since the high technology industrial sector is rapidly expanding, it is composed of an array of different-sized companies. Therefore, data were analyzed by firm size to determine if this had any effect on the percentage demand for vo-tech graduates. Table 3-3 illustrates that the average demand for high technology technicians requiring vocational-technical training appears fairly constant regardless of company size. More research is necesssary to determine if this would hold true in a different sample.

FIGURE 3 - 1

PROPORTION OF VO-TECH TECHNICIANS TO FULL LABOR FORCE FOR 14 GEORGIA HIGH TECHNOLOGY FIRMS *



14 SAMPLE FIRMS

* Of the 16 firms surveyed, one would not release figures and one trained all employees internally.

Table 3-3

DEMAND FOR TECHNICALLY TRAINED WORKERS
BY SIZE OF FIRM

Firm Size	% of Work Force Requiring Vo-Tech Skills
Greater than 1,000 employees	21.4
Greater than 100 but less than 1,000 employees	23.3
Less than 100 employees	22.4

Because firms tended to be involved in several different areas of high technology, no accurate analysis of technician-to-labor-force ratio by high technology area was possible. Much more detailed data collection would be necessary before that information would be accessible.

In examining job classifications requiring vo-tech skills, it was found that firms use a variety of designations for a single job category. Many did not specifically match an established Dictionary of Occupational Titles (DOT) designation. Table 3-4 provides a summary of the many job titles reported in the survey.

Predictably, certain job descriptions obtained for high technology technicians showed a similar range of duties and responsibilities even though they had different title designations. Figure 3-2 shows position descriptions from three firms for similarly titled designations. Only one title specifically matched a DOT designation, yet all three descriptions partially matched the general description afforded by the DOT title of "Electronics Technician."

Table 3-4

TITLES OF JOBS REQUIRING VO-TECH SKILLS
BASED ON SURVEY OF 20 FIRMS

JOB TITLE SAME AS DOT TITLE	JOB TITLE NOT LISTED BY DOT
Design/Development Technician	Test Technician
Avionics Technician	Computer Graphics Operator
Machinist	Production Technician
Mechanic	Drafting Technician
Electronic Technician	Service Technician
Machine Operator	Electronic Instrumentation Technician
Assembler	Test Operator
Wirer	Electronic Test Technician
Electrician	Electronic Repair Technician
Tool Designer	Maintenance Technician
Draftsman	Tube Bend Data Processor
Electrical & Electronics Mechanic	Functional Test Equipment Builder
Set-up Mechanic	Laboratory Instrumentation Technician
Engineering Technician	Industrial Instrumentation Technician
	Hydraulic & Plumbing Development Mechanic
	Machine Tool Programmer
	Tooling Layout Technician
	Electronic Mechanic

FIGURE 3-2

JOB DESCRIPTION COMPARISON

COMPANY A

ELECTRONIC TEST TECHNICIAN - Performs routine calibration, repair and troubleshooting work on instruments, systems and circuits. Records and maintains test data on instruments and electronic subassemblies, makes adjustments or changes in processing equipment to produce microcircuits, thin films and semiconductor devices of specified quality and yield. Uses manufacturing and text documentation to build and test electronic circuits, subassemblies, microcircuits and/or semiconductor devices.

Qualifications

- Experience - None required
- Other requirements- Must satisfactorily complete entry level test
  Must understand fundamentals in assigned field
  Must be able to use more common equipment and instruments including but not limited to: oscilloscopes, voltmeters, power meters, etc.

COMPANY B

ELECTRONICS TECHNICIAN - Demonstrates a working knowledge of analog, digital circuits and ability to troubleshoot circuit cards to component level. ponent levels

Qualifications

- Experience - 6 months to 1 year of relevant experience
- Other requirements - High school equivalent and 2 years of electronics school
  Must be able to read and interpret blueprints and understand test specifications
  Must be able to fully utilize and understand test equipment.

COMPANY C

TEST TECHNICIAN - Sets up and operates a variety of precision test equipment. Makes adjustments in the values and settings of components to align and tune electronic circuits, utilizing limited or no written test procedures. Conducts a variety of functional tests to check operation and calibration of systems. Studies circuits and checks wiring and operation to locate malfunctions found during testing.

Qualifications

- Comprehensive knowledge of electronic test theory
- Ability to competently interpret and evaluate test results
- Ability to write test reports
- Must have good color perception

DOT

ELECTRONIC TECHNICIAN - Applies electronic theory, principles of electrical circuits, electrical testing procedures, engineering mathematics, physics, and related knowledge to layout, build, test, troubleshoot, repair, and modify developmental and production electronic equipment, such as computers, missile-control instrumentation, and machine tool numerical controls. Discusses layout and assembly problems with ELECTRONICS ENGINEER (professional & kindred) and draws sketches to clarify design details and functional criteria of electronic units. Assembles experimental circuitry (breadboard) or completes prototype model according to engineering instructions, technical manuals, and knowledge of electronic systems and components and their functions. Recommends changes in circuitry or installation specifications to simplify assembly and maintenance. Sets up standard test apparatus or contrives test equipment and circuitry and conducts functional, operational, environmental, and life tests to evaluate performance and reliability of prototype or production model. Analyzes and interprets test data. Adjusts, calibrates, aligns, and modifies circuitry and components and records effects on unit performance. Writes technical reports and develops charts, graphs, and schematics to describe and illustrate systems operating characteristics, malfunctions, deviations from design specifications, and functional limitations for consideration by professional engineering personnel in broader determinations affecting systems design and laboratory procedures. May operate bench lathes, drills, and other machine tools to fabricate nonprocurable items, such as coils, terminal boards, and chassis. May check out newly installed equipment in airplanes, ships, and structures to evaluate system performance under actual operating conditions. May instruct and supervise lower grade technical personnel.

This trend in job description similarity was not uniform, however. For instance, one firm had a position titled "Computer Test Technician" with the following description:

> Computer Test Technician: Performs routine testing and troubleshooting of printed circuit and systems. Interfaces computers with peripherals (i.e., inserts printed circuit boards, attaches cables, and configures software).

This description also closely mirrored the DOT description for an electronics technician. In fact, the alternative designation listed by DOT for "Electronics Technician" is "Computer Laboratory Technician." However, nowhere in the DOT description was there mention of configuring software. Often companies have unique requirements which necessitate a specific training background in addition to the more general job requirements. This helps to explain some of the training deficiencies reported in this survey regarding the quality of vo-tech graduates.

What became obvious in the overall analysis was that the firms interviewed required a mixture of electronic, electromechanical, and mechanical skills in their technical labor force. It was also revealed that engineering and scientific technicians, a classification not being trained currently in vo-tech schools in Georgia (See Appendix C), were also in high demand. One firm estimated that it would need approximately 80 additional technicians with this training in the next five years alone. These unique training demands stress the requirement for a strong industry/school interface if industry needs are to be fulfilled.

The relationship between company size and company willingness to hire vo-tech graduates was also examined. Referring to Table 3-2, no correlation was found between company size and the hiring of personnel with vo-tech skills. Two large firms (employing over 1,000) indicated they did not use vo-tech graduates because of the strength of their own internal training programs. However, two other large firms indicated that they actively hired vo-tech graduates. Smaller firms (less than 1,000) fell into one of two categories: those hiring primarily experienced applicants and those actively seeking vo-tech graduates as part of their overall hiring plan. Of the nine firms reporting employment of less than 1,000 people, three fit the first designation and six the second.

Table 3-5 describes the recruitment methods reported by those Georgia companies hiring high technology vo-tech graduates. While indirect, it provides some measure of interaction between the companies and vocational-technical schools. Only one company showed considerable interaction with a vo-tech school. This firm commented on being actively involved in advising the local vo-tech school of its training needs. Other comments from firms revealed a shortage of adequately trained technicians in Georgia. Two companies stated that they hired most of their technicians outside the state. Six firms remarked that they had to provide fairly extensive training after employment for the vo-tech graduates they hired.

To determine how they felt about the vocational-technical system in Georgia, firms were asked about their general experience with vo-tech graduates and what skills, if any, these graduates tended to lack. For the most part, firms employing vo-tech graduates felt that those skills being taught were relevant to their needs. However, many firms expressed concern regarding the depth of training these students had received, citing their lack of fundamental skills. Listed in Table 3-6 are the skills identified as often deficient in vo-tech graduates hired. Each deficiency is followed by a percentage reflecting the number of companies reporting that deficiency.

Deficiencies resulting from lack of basic technical skills and outdated equipment/curriculum were most often cited by Georgia high technology firms. Four companies reported general education skills deficiencies in math, science, and communication. This is a severe problem common to employers on a national scale. Of the 16 Georgia firms contacted, 5 do not use vo-tech graduates. All other Georgia firms reported at least one deficiency as

Table 3-5

METHODS OF RECRUITMENT FOR HIGH TECHNOLOGY
VO-TECH GRADUATES UTILIZED BY GEORGIA FIRMS

Company	Vo-Tech Graduates Hired		Method of Recruitment			Number Hired Annually	COMMENTS
	YES	NO	Direct	Industry Day	Placement Service		
A	●		●			N/P	Advises school on curriculum needs
B	●		●	●	●	N/P	Wants more experience
C		●				6	
D	●		●		●	15	
E	●		●	●	●	4	
F		●					
G	●				●	2	
H		●		●			Trains internally
I	●		●	●		N/P	Requires OJT for 2 to months after placemen
J		●				4	Requires experience
K	●		●	●	●	N/P	
L			●	●	●	10	Hires as trainees
M	●		●			2-4	Hires as trainees
N		●					
O	●			●		125	Hires only 10% in GA
P	●		●			880	Hires only 20% in GA

N/P = Not provided

Table 3-6

TRAINING DEFICIENCIES
REPORTED BY INDUSTRY

Deficiency*	Georgia Firms	
	Number	Percent
Lack of Basic Technical Skills		
Basic electronic skills (analog)	5	31.2
DC & AC theory	1	6.2
Hexadecimal system	1	6.2
Reading schematics/prints	2	12.5
Soldering skills	2	12.5
Transistor theory	1	6.2
Understanding of Boolean algebra	3	18.8
Number of companies reporting	10	62.5
Outdated Equipment/Curriculum		
Hands-on experience	8	50.0
Experience with latest equipment	3	18.8
Computer & microprocessor languages	1	6.2
Familarity with current reference books	1	6.2
I.C. insertion techniques	1	6.2
Microprocessor interfacing	3	18.8
Number of companies reporting	8	50.0
General Education Skills		
Communications skills	1	6.2
Basic Math	2	12.5
Recordkeeping	2	12.5
Basic Science	1	6.2
Number of companies reporting	4	25.0
Other		
Interviewing skills	1	6.2
Hydraulics	2	12.5
Metallurgy	1	6.2
Pneumatics	2	12.5
Production testing	2	12.5
Tool & die	1	6.2
Troubleshooting skills	2	12.5
Number of companies reporting	6	37.5
No Deficiencies Reported	-	----
Do Not Use Vo-Tech Graduates	5	31.2
TOTAL COMPANIES	16	100.0

* Companies often cited more than one deficiency.

characteristic of the vo-tech graudates hired. More surprising, however, out-of-state companies had few criticisms to make about vocational-technical training in their states. Based on courses taught by these state schools in high technology programs, it appears that North Carolina, South Carolina, and Tennessee are graduating technicians better prepared for entry into high technology firms than graduates of Georgia vo-tech schools. However, it must be stressed that our survey included a very small sample population of out-of-state firms.

D. EVALUATION OF FINDINGS

With the information gathered from discussions with industry, an overall view of high technology industry's perception of the vo-tech system was developed.

While firms generally commented that they worked with the vocational-technical schools, they also seemed to realize that they could do more to help maintain the currency of vo-tech programs in their area. Many of the firms contacted either had contributed to vo-tech programs or felt they could do so if called upon.

Most of the larger firms contacted had some sort of in-house training program to enhance the skills of their employees. These were necessary either because of voids in the employees' basic training or new technological developments. However, companies noted that training programs can quickly become obsolete. Therefore, progressive firms were found to be constantly updating their training programs. It was pointed out in discussions that industry did not expect to hire vo-tech graduates ready to be placed immediately in responsible positions. Instead, firms require workers with sufficient training in the basics and with enough experience on modern equipment to allow the company to raise the employee quickly to a responsible position through general corporate training or apprentice programs.

One of the most frustrating aspects of the survey was identifying industry's training needs in the area of specific skills required. As illustrated in Table 3-4, in many instances, job titles and descriptions varied in substance from DOT classifications. Obviously, this implies difficulty with providing job-specific training for every individual company's needs. However, certain basic skills through which firms can quickly orient the individual to specific job requirements are required of every technical employee. Advanced technology support requires a broad mix of skills. This implies the need for greater emphasis on cognitive rather than manipulative skills. The student that understands "why" as well as "how" will have greater flexibility in applying the skills he or she has learned to a rapidly changing job environment.

E. PROBLEM AREAS

The following current technology problem areas were identified in the Georgia vo-tech system by industry:

Equipment - Graduates do not always have a working knowledge of equipment commonly used in high technology operations. Lack of up-to-date experience often lengthens the training period necessary for a new applicant.

Skills - Graduates do not always possess certain basic technical and general education skills. These skills are considered extremely important in providing a foundation on which industry-specific training can be built.

Quality of Students - Vocational-technical schools do not always attract bright, energetic students. Yet new technologies require intelligent individuals able to grasp new and complex concepts quickly. Many firms supported the concept of upgrading the image of vocational-technical education to help attract such students.

Training Programs - In visiting companies outside Georgia, no major complaints were voiced about the post-secondary vocational-technical schools in South Carolina, North Carolina, or Tennessee. Admittedly, the out-of-state sample was rather limited (four companies), but none of the firms visited in Georgia were so kind. Transcripts of job applicants applying to these out-of-state firms revealed that vocational-technical schools in North Carolina and South Carolina are providing courses in calculus, physics, and other hard sciences which give the graduate a more fundamental scientific understanding of specific skill areas. If training curricula included more basic math and science offerings, the qualifications of vo-tech graduates would rise and would make these graduates more flexible and effective workers.

In talking to industry, it was revealed that videotape training programs were in use in most of the larger industrial firms with training departments. Many smaller firms contacted had no training personnel whatsoever but were still interested in utilizing some form of in-house training. Used as a means to increase worker productivity and to train workers for more advanced jobs, internal training is becoming more popular. For instance, one major firm estimated that it gave training via classroom instruction and videotape presentations to its employees approximately 10% of the time. (This number was arrived at by examining employee records of those who had been with the company for 10 years. It was calculated that the average employee in that firm received 50 weeks of training over this period). This figure is very indicative of what experts expect will become commonplace. More successful companies are learning that it is necessary to train and update their personnel continually. More update training programs by private and public institutions are clearly indicated.

<u>Teacher Update</u> - One of the major conclusions drawn from the many industrial interviews conducted is that the success of a vo-tech program is <u>very</u> dependent on the presence of a capable, intelligent, progressive instructor for the subject area. According to industry, instructors should be required to spend more time in industry in order to keep up-to-date on the latest techniques and equipment. This is extremely important, and industry is encouraging the state to support this type of cooperation.

Several industrial representatives pointed out that this was being done in other states and was working very well.

In summary, equipment, skills, quality of students, training programs, and teacher update are the concerns of high technology industry as they look to the vo-tech graduates as valuable, well-trained employees.

SECTION IV

SCHOOL SYSTEM'S PERCEPTION OF THE CURRENT VO-TECH SYSTEM IN GEORGIA

A. INTRODUCTION

This section presents a synopsis of the current vo-tech system in Georgia and discusses results of a survey conducted with vocational-technical school directors.

Inquiries into the current vo-tech system focused on seven distinct areas. These areas, which are compared to systems in eight other states (see Section V), are as follows:

1. Educational Structure
2. Program Offerings
3. Teacher Updates
4. Industry/School Interface
5. Teacher Salaries
6. Vo-Tech Image
7. The Economy

The survey of vo-tech school directors focused on perceived barriers to the successful implementation of high technology programs and potential strategies to overcome those barriers.

B. GEORGIA'S CURRENT SYSTEM

1. Educational Structure

Overall governance of the educational system in Georgia is the responsibility of the State Board of Education and the Board of Regents. The State Board of Education has responsibility both constitutionally and statutorily for general supervision of K-12 and vocational-technical programs in secondary and post-secondary schools. The Governor appoints the members of the Board of Education and, by law, the elected State Superintendent is the executive officer of the State Board of Education.

The Board of Regents has both constitutional and statutory responsibility for the supervision of higher education. Its responsibility includes vocational-technical programs in junior colleges, senior colleges, and universities.

Thus, governance and regulatory responsibilities for vocational-technical education are divided among several authorities at different levels. At the state level, vo-tech is divided between the State Board of Education and the Board of Regents, depending on the location of the program. At the local level, governance of vocational-technical education is divided between city or county school boards and area boards of education.

2. Program Offerings

Georgia's vocational-technical schools offer a variety of courses of study, as Table 4-1 shows. Of 30 schools, all but one offer some high technology training. Courses in computer and computer services are most prevalent, with electronic technology almost as popular. Current high technology courses offered include programs in:

Computer/Computer Services
Drafting/Design Technology
Electrical Technology
Electromechanical Technology
Electronics Technology
Industrial Electronics Technology
Industrial Plant Maintenance
Instrumentation Technology

TABLE 4-1

Vo-Tech Program Locations

	Albany	Americus	Athens	Atlanta	Augusta	Bainbridge	Brunswick	Carrollton	Clarkesville	Clarkston	Columbus	Dalton	Fitzgerald	Gainesville	Griffin	Jasper	LaGrange	Macon	Marietta	Morrow	Moultrie	Rock Spring	Rome	Savannah	Swainsboro	Thomaston	Thomasville	Valdosta	Warner Robins	Waycross
Accounting	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Air Conditioning	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Alterations and Fashion					●									●																
Appliance Servicing				●					●		●					●	●					●	●							
Auto Body Repair	●	●	●	●	●			●	●		●	●	●	●	●	●	●	●	●		●	●	●	●		●	●	●		●
Auto Mechanics	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Aviation Mechanics		●		●																										
Barbering				●														●						●						
Business Machine Maintenance		●	●																											
Carpentry	●	●		●	●				●		●		●	●	●	●	●	●					●	●		●				
Chemical Technology																								●						
Child Development	●		●	●	●				●	●				●				●						●	●				●	●
Civil Technology				●																				●						
Clerical	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Clothing Management	●																													
Commercial Art				●						●																				
Cosmetology	●	●	●	●	●			●	●	●	●		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Data Processing	●	●	●	●	●	●	●		●	●	●			●	●	●		●	●			●	●	●	●		●	●		●
Dental Assisting	●		●	●																										
Dental Lab Tech.				●	●																									
Diesel Mechanics	●	●		●						●	●	●	●								●			●			●	●		
Drafting	●	●		●				●		●		●	●		●		●						●	●	●	●		●	●	●
Drafting/Design Tech.	●		●		●		●		●		●	●				●		●	●		●	●	●	●			●	●		
Electrical Wiring	●	●	●	●	●	●	●	●		●	●			●	●				●				●	●		●	●	●		
Electrical Technology					●				●	●									●					●	●					
Electromechanical Tech.			●							●			●				●		●							●				
Electronics Technology	●	●	●	●	●				●	●	●			●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
Emergency Medical Tech.					●					●			●															●		
Food Services			●	●	●								●					●											●	
Graphic Arts/Printing	●			●	●					●	●							●	●										●	
Industrial Electronics Tech.	●		●				●					●						●					●							
Industrial Plant Maintenance	●	●			●									●		●								●			●	●		
Instrumentation Technology					●																			●						
Machine and Tool Design									●		●																			
Machine Shop	●	●		●	●		●	●		●	●		●	●	●	●	●	●	●		●	●	●	●	●		●	●		
Marketing/Management	●		●		●	●	●				●	●											●	●	●			●		●
Marketing/Sales				●	●			●							●			●											●	
Masonry	●	●		●	●	●			●		●		●	●		●	●	●					●	●		●	●		●	
Mechanical Technology			●							●													●							
Medical Assisting	●		●	●	●					●	●					●		●					●	●	●					
Medical Lab Technology	●			●	●		●		●	●		●		●				●										●		●
Medical Secretary					●		●		●			●																		●
Mini Computer Technology												●																		
Operating Room Technology			●				●			●																		●		●
Optical Lab Tech.										●																				
Ornamental Horticulture	●				●				●																					
Photography									●																					
Plumbing		●							●				●																	
Practical Nursing	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Radio TV	●	●	●	●	●			●		●	●		●		●			●	●			●	●	●		●				●
Research Lab Tech.			●																											
Respiratory Therapy					●		●																				●			
Secretarial	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Small Engine Mechanics									●					●			●		●					●						
Textile Technology																	●													
Upholstery		●									●																			
Watch Repair									●																					
Welding	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●	●	●	●	●
X Ray Technology	●						●										●											●		●

Source: Skills for Success through Georgia's Vo-Tech Training, Georgia Department of Education, 1981.

Machine and Tool Design
Machine Shop (some programs)
Mechanical Technology

For a pilot program to begin in Fall 1982, Georgia completely revamped high technology curricula in electronics, electromechanical technology, and mechanical technology. State-of-the-art equipment has been ordered, new instructors hired, current instructors updated, and course content revised to place more emphasis on technical courses. Three schools--DeKalb, Columbus, and Augusta Area Vocational-Technical Schools--will implement these programs on an accelerated basis leading to an Associate of Applied Technology degree. Incorporating successful aspects of out-of-state programs, the updated curricula place more emphasis on fundamental and cognitive earning. The number of hours of technical training necessary for the degree exceeds ABET requirements. These upgraded programs will graduate technicians with "hands-on" experience as well as the flexibility to absorb new technological developments readily. Therefore, graduates should be more attractive to industry. Electronics, electromechanical, and mechanical technology curricula at three other vocational-technical schools (Athens, Marietta-Cobb, and Savannah) will also be updated to the pilot level, but at a slower pace.

Until the State Board of Education approved the granting of degrees by vo-tech schools in the pilot program, associate degrees had been available in some of Georgia's vo-tech programs only upon completion of the same general education requirements as an associate of arts degree--45 quarter hours of core technical training and 45 hours of general education courses. These degreees are granted through junior or senior colleges rather than by the vocational-technical schools themselves.

3. Teacher Update

In Georgia, skills updating for teachers is accomplished in a variety of ways. In-service conferences are presented both locally and on a statewide basis. Local education institutes conduct staff development courses that generally attract specialized teachers from an entire region. College or graduate school programs are completed on an individual basis.

Because high technology fields are subject to rapid and continual change, the availability of mechanisms to ensure the currency of instructional personnel in these fields is critical. A new emphasis is being placed on staff development seminars specific to high technology. Programs recently presented for high technology instructors were:

- Real Time Application of Microprocessors in Robotics (2 days)
- Advanced Communications (2 days)
- Implementing High Technology Programs in Vocational-Technical Schools (5 days)
- Robotics (1 day)
- Troubleshooting Digital Circuits (2 days)
- Troubleshooting Analog Circuits (2 days)
- Models, Simulators, and Training Devices (2 days)

Participation in Project Update is another means of enhancing skills. Project Update is a free service provided to all vocational-technical techers with renewable teaching certificates. This program provides a framework for skills updating through a return to industry. Project Update personnel assist each teacher applying for credit towards recertification in developing a suitable training program, usually skills updating through a short-term return to industry. Training objectives, length, site, and type of experience are specified and approved by both the teacher and local school before starting. A formal agreement as to how the experience will be used in teaching (through lectures, demonstration, lab, or a field trip) also is made. A follow-up visit confirms the success of the project and its proper utilization in the classroom through interactions among Project Update personnel, the teacher involved, the appropriate supervisor, and a peer teacher. Between 150 and 200 secondary and post-secondary teachers participate in Project Update each year. However, the Department of

Education estimates that post-secondary high technology teachers account for only 15% to 20% of these.

Certification of new teachers in Georgia is conducted through the competency-based teacher certification program. This program is design to assess competencies through the administration of a criterion-referenced test and on-site assessment.

There are three components of the competency-based teacher certification program: subject matter testing, on-site assessment of teaching competencies, and successful completion of 30 hours of teacher education within the first three years of employment. When these three components of teacher certification are successfully completed, a teacher is given a certificate for a designated time.

Both post-secondary vo-tech school directors and legislators have expressed concern that the educational system may not be able to find qualified high technology instructors able or willing to meet certification requirements in Georgia. In a January 1981 report by the Vocational-Technical Governance Study Committee, a recommendation was made to reorganize the certification procedures for the vocational teacher certificates. This recommendation is still under study.

4. Industry/School Interface

Georgia's vocational-technical school system has both a local and a State Advisory Committee. The State Advisory Council on Vocational Education in particular is very supportive of vo-tech programs. In addition to providing input on curriculum, the Council makes recommendations to the State Board of Education on significant issues, conducts conferences, offers assistance to local advisory committees, and cooperates with other boards and committees concerned with vocational-technical education.

An advisory committee for high technology training programs was recently established. The twelve-member board was appointed by the Governor to assist in high technology curriculum development, encourage industry/school interfacing, and aid in long-range planning efforts.

A selection committee is now finalizing criteria for the High Technology Coordinator position recently created within the Department of Education. The Coordinator will act as a liaison between the high technology advisory council, vocational-technical schools, and the Department of Education/State Board of Education.

Presently most industry/school interface occurs on a local level between individual vo-tech teachers and local industry. The initiation of cooperative work experience programs is frequently the result of these close working relationships. Some vo-tech schools provide complete training for new personnel needed by a particular company or entity. For instance, the Augusta Area Vocational-Technical School has a cooperative program with Columbia Nitrogen in Industrial Maintenance. Students successfully completing the full eight-quarter sequence are guaranteed a job as an Industrial Maintenance Technician at a starting salary of $30,000. Warner Robins Air Force Base has an agreement with the Houston Vocational Center for the training of Electronics Mechanics. Graduates receive an average annual salary of $20,000. More than 125 students are on the waiting list for this program.

Both local and out-of-state industries have donated equipment to traditional vocational-technical programs. This practice is continuing in the high technology programs. Attempts are being made to gain permission for companies to allow the loan of equipment or to schedule classes in the plant for certain specialized courses, such as computer-aided drafting. Cooperation of this type should be greatly enhanced through the efforts of the High Technology Advisory Council and the High Technology Coordinator.

5. <u>Teacher Salaries</u>

Effective September 1981, the starting monthly salary for a post-secondary teacher with a V-4 certificate (four-year educational degree) is

$1,266. If the teacher is a qualified occupational teacher with appropriate work experience, he or she may be moved up as many as three steps on the vocational pay schedule to $1,361. Work experience must be beyond the minimum required by the State Department of Education for initial certification.

Bureau of Labor Statistics data (Bulletin 2045, October 1979) show that monthly salaries for engineering technicians ranged from $902 to $1,685 in 1979. Adjusting these figures to 1981 using a conservative 7.12% annual salary increase would put engineering technician salaries at $1,035 to $1,933 per month. However, according to a study by the Engineering Manpower Commission of the American Association of Engineering Societies, median salaries of technicians and technologists rose 25.3% from 1979 to 1981 with mid-point salaries for non-degreed technicians at $1,620, associate-degreed technicians at $1,725, and bachelor-degreed technologsts at $1,812. Since the national shortage of qualified technicians is still severe, firms are willing to pay these experienced technicians to stay in industry. Post-secondary vocational-technical school staff members have expressed concern that they cannot find qualified instructors for the low salaries Georgia offers.

6. Vo-Tech Image

Vocational-technical education programs are often viewed as trade and craft oriented, attracting students who cannot succeed at colleges and universities. High technology industry, however, with its heavy demand for skilled technicians to manufacture, use, troubleshoot, and/or repair complex equipment and its ability to pay high salaries, is changing this attitude.

Georgia educators increasingly recognize the importance of high technology training. This type of training is a realistic alternative to college for many students, and secondary school guidance counselors are beginning to encourage students to explore the myriad career opportunities offered by high technology training.

In an effort to improve the substance of vo-tech programs in the state, Georgia has taken several steps which are already resulting in an enhanced image. These measures should yield better prepared students able to meet the employment needs of high technology industry.

7. The Economy

Post-secondary education in Georgia is supported by federal, state, and local funds. Most funding for education in Georgia is supplied by the state. In order to upgrade targeted high technology training programs, the state has allocated an additional $8 million for the purchase of equipment.

The funding available for education in any state is subject to the general health of that state's economy, and fluctuations in the state's economy are necessarily reflected in allocations for education. Georgia is fortunate in having a broader-based economy than many states in the Southeast. The Governor's office is intensifying efforts to attract more industry to the state in order to further improve Georgia's economic stability.

Upgrading current high technology training programs and implementing new programs will allow the expansion of present high technology firms and help attract new firms. While much of the present high technology industry in the state is located in or near Atlanta, increased availability and range of technicians will encourage siting in more rural areas. The growth of present firms, coupled with the establishment of new industries throughout the state, will contribute to the state's economic well-being and help ensure adequate funding for post-secondary vo-tech programs.

C. SURVEY OF VOCATIONAL-TECHNICAL SCHOOL DIRECTORS

1. Perceived Barriers

As part of the analysis of the Georgia vocational-technical education system, a survey of area school directors was conducted to determine perceived barriers to the implementation and/or upgrading of high technology programs and to develop potential strategies to overcome these barriers. Thirty school directors were mailed a survey form requesting input on barriers to high technology training, delivery systems, and present needs. Comments concerning high technology training programs in vocational-technical schools were also invited. (A copy of the survey form appears as Appendix D.)

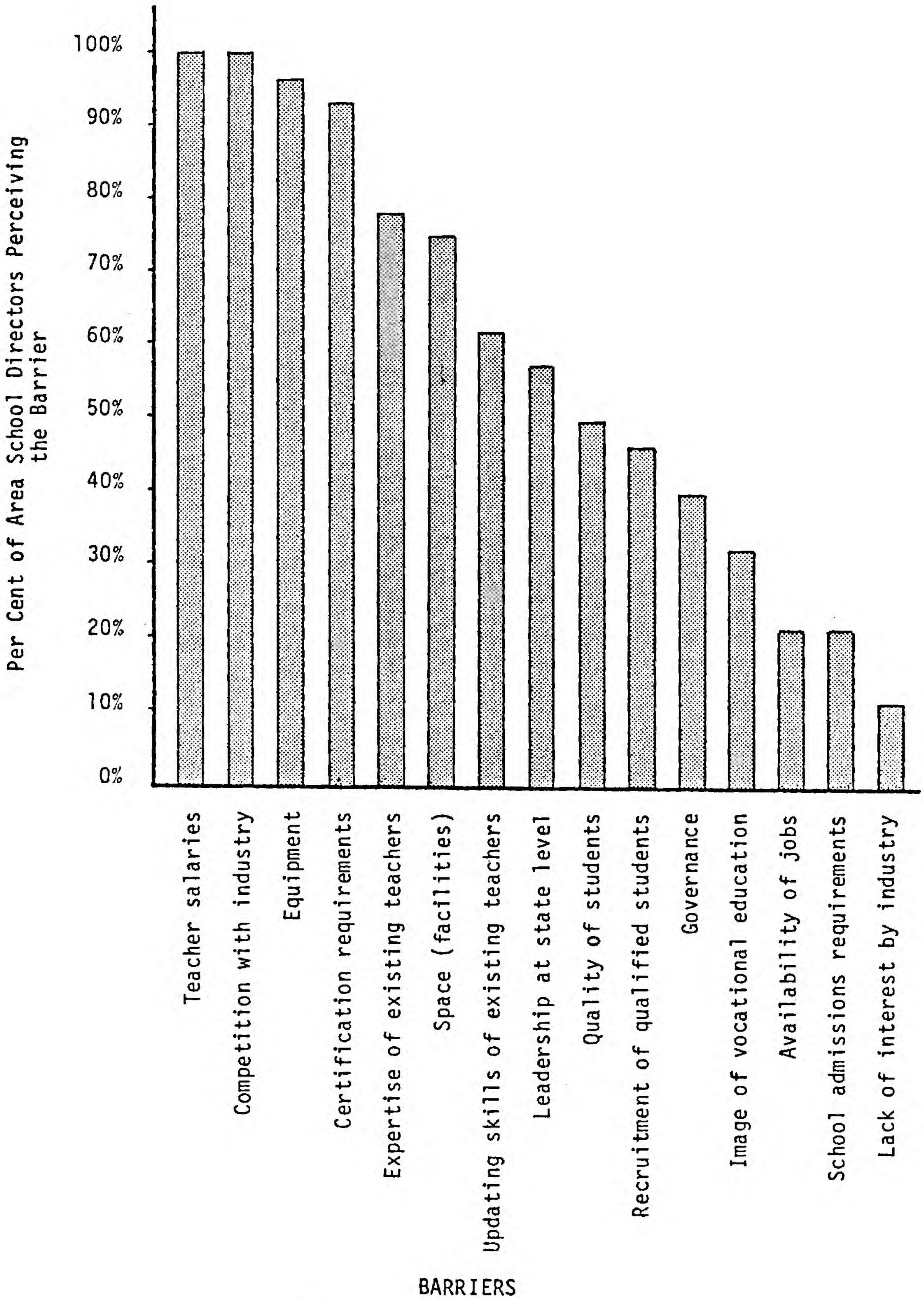
Directors of twenty-eight schools responded to the questionnaire; results are discussed in detail below. Figure 4-1 presents a summary of the percentage of directors identifying each specific barrier as a problem.

Low Teacher Salaries. All twenty-eight school directors stated that teacher salary limitations are a problem in implementing high technology programs. One director asked, "Where can you find an experienced high technology technician for $16,000 per year?" As expressed earlier, this problem has been significant for some time. Post-secondary vo-tech school directors expressed deep concern in their Fall 1980 position paper that qualified instructors may not be found for the salaries Georgia offers. In January 1981, a joint report of the Vocational-Technical Governance Study Committee on Education and the University System of Georgia Committee of the Georgia House of Representatives supported this concern. A similar situation exists in each of the other eight states contacted (See Section V).

Competition With Industry for Qualified Personnel. All of the post-secondary school directors agreed that competition with industry for qualified personnel is a severe problem. Due to the current scarcity of experienced high technology personnel, industry and training programs will continue to compete for the same personnel. It is evident that industry has been willing and able to attract and keep qualified personnel, while schools can do little, particularly regarding salaries. Remarks one director, "With beginning salaries for technical school graduates currently exceeding our instructors' salaries, there is little hope of attracting qualified instructors from industry."

FIGURE 4-1

BARRIERS PERCEIVED BY AREA SCHOOL DIRECTORS



Without these qualified people to teach in high technology programs, education will continue to lag behind state-of-the-art technology. Fortunately, high technology companies are beginning to understand that threat and are working more often with schools to develop methods of overcoming this problem.

Equipment. Twenty-seven of the directors (96.4%) stated that lack of equipment was a problem in implementing high technology programs in their schools. Traditionally, obtaining up-to-date equipment in vocational-technical schools has been a problem. Since the vo-tech philosophy is to provide convenient training to all students who apply, the growth of schools has left limited funds for updating equipment. The equipment replacement budget for the vocational-technical system was $2.5 million in fiscal year 1979 and remained at that level through fiscal year 1982.

The legislature in January 1981 reported the results of a survey of equipment in post-secondary vo-tech schools. The majority of equipment in the post-secondary schools was found to be satisfactory. The criteria used to determine equipment condition, however, were not clear. In high technology areas, where technological changes take place very rapidly, an outdated piece of equipment may be useless for training despite its being in good working order.

Action is being taken to combat this problem. Monies recently allocated by the state legislature will ameliorate the problem for some of the most critical high technology programs. Overall solutions, however, require long-range planning and intense cooperation between industry and schools.

Directors also pointed out other problems with equipment for high technology programs. Because of equipment purchase procedures, getting appropriate equipment into schools quickly is a problem. Finding time for instructors to familiarize themselves with the equipment is another difficulty.

Certification Requirements. Twenty-six of the post-secondary directors (92.9%) stated that certification requirements are a problem in implementing high technology programs in their schools. The main problem with certification lies in trying to attract new teachers rather than recertifying existing teachers. A typical comment reveals directors' concerns: "If we were fortunate enough to hire a skilled technician today, he or she would be near obsolete before completing the state's certification requirements which are mandated over the first three years of employment." Directors also pointed out that instructors for junior college-based vo-tech programs have no certification requirements. Difficulties related to recertification, particularly the education course requirements, also surfaced.

It should be noted that certification itself is probably not the main problem. Competency in technical fields as well as competency in educational skills cannot be disputed as requirements for a successful teacher. However, certification requirements in conjunction with low pay scales and a heavy workload makes the prospect of taking required education courses with no emphasis on keeping up-to-date within one's technical field extremely unpalatable.

Expertise of Current Teachers. Twenty-two directors (78.6%) reported current teachers' levels of expertise as a problem in implementing high technology programs. Before high technology courses can be offered, qualified teachers must be available to teach them. Particularly with the shortage of skilled technicians, schools are increasingly dependent upon existing personnel. High technology areas are characterized by frequent and drastic changes in the knowledge necessary to provide training; thus, current teachers generally cannot provide state-of-the-art courses without further updating.

Even for those teachers with the basic background for a course, time is so limited that sufficient updating is frequently impossible. Instructors generally teach twelve months a year and have little free time. Even those days mandated for further training are lost. States one director, "In-service days are used to maintain student grade and attendance reports and other related student records." With the rapid rate of change in high technology areas, expertise will continue to be a problem.

Space (Facilities). Twenty-one of the vo-tech school directors (75.0%) said space was a chronic problem in implementing high technology programs. A joint Vocational-Technical Education Study Committee reported in December 1979 that space was severely limited in many of the older post-secondary schools. The problem today is essentially the same.

Many high technology courses have long waiting lists of students, with little room or money to expand existing facilities. A January 1979 report to the Office of Vocational Education by Zimmerman, Evans, and Leopold, Inc., proposed a master plan for post-secondary vocational-technical schools. While the report provides a systematic plan to expand existing facilities, much of what exists appears to be inflexible. There is also little incentive for schools to phase out programs for which little or no need exists.

Updating Skills of Current Teachers. Seventeen directors (60.7%) stated that updating skills of teachers in high technology programs is a problem in their schools. Some programs are available, particularly with the new statewide emphasis on high technology. Time appears to be the major difficulty. Many vo-tech teachers are overloaded. Dedicated teachers already spend after-school hours, holidays, weekends, and vacations trying to keep up by visiting local industries, reading trade journals, and attending available staff development programs. Release time for teachers to upgrade their skills is limited to 48 days in a three-year period, subject to approval by the area school director. State funds do not provide for a substitute's salary.

Leadership at the State Level. Sixteen of the post-secondary vo-tech school directors (57.1%) stated that leadership at the state level is a problem in implementing high technology programs in their schools.

Only recently has a mechanism existed for defining and directing the technical path that schools should be taking to meet future needs of high technology industry. This lack of specific direction was a major concern in the Fall 1980 position paper of the Georgia Area School Directors' Association. Area school directors specifically asked for strong leadership at the state level to support and encourage the development and implementation of high technology training programs.

Multi-authority governance of vocational-technical programs causes additional difficulty. Post-secondary training programs in the vo-tech schools are governed with K-12, while junior college programs are governed with higher education. With no well-defined position of their own, these programs are often overlooked. However, creation of the High Technology Coordinator position should alleviate some of these problems.

Quality of Students. Fourteen directors (50.0%) stated that the quality of students is a problem in implementing high technology programs. High technology training requires a much deeper math and science background than other programs. One school reports, "One-half to three-quarters of technical school beginning electronics students lack skills in algebra competencies that are necessary to begin technical instruction." Remedial courses have been instituted at the vocational-technical schools, but this places an additional burden on the schools.

Colleges are having the same problems. A May 17 article on illiteracy by U.S. News & World Reports states that increasing numbers of college students, sometimes up to half the freshman class, require remedial studies. Nationally, few secondary students take the math, science, or communications courses necessary for even basic preparation for advanced study.

Recruitment of Qualified Students. Thirteen of the post-secondary vo-tech school directors (46.4%) reported that recruitment policies represent a barrier to implementing high technology programs. Some directors blame the "open door" policy. Stated one, "Federal and State laws make it almost impossible to screen and select well-qualified students for our programs." Although potential students are tested and counseled prior to entering the field of their choice, by law all students must be accepted.

Governance. Eleven post-secondary vo-tech directors (39.3%) stated that governance is a problem in implementing high technology programs in their schools. Of the eleven, 36.4% came from directors governed by area school boards and 63.6% from directors governed by local Boards of Education. Several directors specified, however, that they referred to state rather than local governance as a problem.

Governance of vocational-technical education is a recurring issue. The joint Vocational-Technical Education Study Committee report of December 1978 stated that overall governance, especially of post-secondary vocational-technical education, is divided unequally among many authorities. No single agency has primary coordinating authority for all components of vocational-technical education, especially the post-secondary component.

Governance was also cited as a potential problem by the Georgia Educational Improvement Council in its December 1978 report. The report provided an overview of coordinating efforts for the governance of vocational, educational, and manpower development. In the January 1981 legislative committee report, a recommendation was made that a position of Associate State Superintendent of Post-Secondary Vocational Education be created. The Georgia Area School Directors' Association took a similar position in its paper in the fall of 1980.

While at present no major changes in the governance of vocational-technical education are planned, the High Technology Coordinator will assist in organizing and coordinating high technology training programs throughout the state.

Image of Vocational-Technical Education. Nine of the vo-tech directors (32.1%) stated that the image of vocational-technical education is a problem in implementing high technology programs. Schools are reporting, however, that the vo-tech image is improving. Due to high salary levels and career opportunities, high technology occupations have much greater status than traditional vocational occupations.

With college tuition costs rising rapidly and jobs for college graduates with nontechnical degrees more difficult to find, more students who a few years ago would have gone to college are now enrolling in high technology training programs. As the educational level and the quality of technical expertise of vo-tech graduates rise, the image of vocational-technical education will further improve.

Job Availability. Only six of the vo-tech school directors (21.4%) stated that the availability of jobs is a problem in implementing high technology programs. Five of these schools are in rural areas without high technology companies. One school is in an area with increasing high tech employment, but the director felt that job availability could be a problem in some of the proposed high technology programs.

Many schools commented that at least some of their high technology programs are not state-of-the-art. Most need curriculum revision, additional equipment, and updating of teachers. Recent appropriations and implementation of the pilot high technology programs will greatly improve this situation. As more qualified technicians are trained, more companies will be interested in siting their facilities in Georgia and hiring local vo-tech school graduates.

Within the vocational-technical system there are some safeguards against training students without the likelihood of their potential employment. Each school must perform a needs analysis before a new program can be implemented. Placement rates are mandated at a minimum of 75%; teachers therefore stay apprised of job opportunities with local industry and guide their students accordingly.

Table 4-2 illustrates system-wide placement data for five selected high technology training programs in Georgia. Positive placements include employment in the training field, in a related field, continuation of schooling, and entry into the military. "Status unknown" is considered a negative result, as is employment in a field unrelated to training.

Computer courses of some type are taught in all but 6 of the 29 schools. The overall placement rate of 86.5% includes poor individual rates at four schools with graduates whose job status was unknown or who had accepted jobs in a different field. Electronics technology programs are offered at 25 schools and boast a higher overall placement rate of 93.1%. The few smaller programs in this field generally have lower placement rates. The highest overall placement rate (95.9%) represents electromechanical technology programs. This relatively new program has an up-to-date curriculum and is only offered in four schools. In addition, three of the schools are located in large urban areas where high technology industry is more concentrated. Drafting occupations programs are offered in 16 schools with an overall placement rate of 85.5%. Again, two individual low placement rates, which appear to result from the schools having lost touch with graduates ("status unknown"), are included in this total. Outdated curricula may also play a role in keeping placement rates down in this field. The overall placement rate for mechanical technology programs is 93.2%. Each of the 14 schools which offer this program has a good individual placement rate. Appendix E contains a breakdown of placement rates for individual schools.

Table 4-2

PLACEMENT DATA IN SELECTED HIGH TECHNOLOGY PROGRAMS
1981

Program Area	Available for Employment	Positive Placements	Employed in Unrelated Field	Status Unknown	Not Employed	Placement Rate
Computer-Related Technology	541	468	17	14	42%	86.5%
Electronics Technology	403	375	12	5	11%	93.1%
Electromechanical Technology	73	70	1	1	1%	95.9%
Drafting Occupations	234	200	12	11	11%	85.5%
Mechanical Technology	191	178	5	3	5%	93.2%

If these figures were interpreted to reflect high technology job openings, Georgia would be performing adequately to fulfill industry needs. From surveying industry and schools, however, it is clear that other variables must be considered. Some companies commented that they had to go out-of-state to recruit qualified technicians, and most vo-tech school directors stressed that their courses and teachers need updating. An improved training program image also will attract better prepared students, with a resultant rise in the quality of graduates.

School Admissions Requirements. Six school directors (21.4%) reported that a lack of school admissions requirements were a problem in implementing high technology programs in their schools. At this time, many post-secondary vo-tech schools have an open-door policy. Aptitude testing is now conducted as an aid to counseling. The Career Planning Profile (admissions test) has been field-tested to determine its validity as an admissions requirement. Norms have been established for the majority of instruction programs, and the Career Planning Profile will be implemented statewide during 1982. A validated admissions system is of increasing concern due to the greater amount of technical training necessary to prepare students for employment.

Lack of Interest by Industry. Only three directors (10.7%) stated that lack of industry interest was a problem in implementing high technology programs. All of these were from rural areas with no proximate high technology industry.

2. Perceived Changes Required

In the survey, vo-tech school directors were asked not only to identify barriers to implementing high technology programs, but also what mechanisms should be instituted to make the vocational system more responsive to future industry needs. Directors were asked to rate location, methods of instruction, and coooperative teaching choices from 1 to 5, where 1 represented "extremely effective" and 5 represented "least effective." In response to a question about where high technology programs should be offered for most effective results, average rankings were as follows:

Location of High Technology Programs	Rank
Only schools near an industrial region offering high tech employment	2.0
All schools	2.9
Specialty center within one existing school	3.2
An industrial facility or resource center outside the vo-tech system's existing schools	3.9

In response to a question about how effective the following methods of instruction would be for high technology courses, average ranking was as follows:

Methods of Instruction	Rank
On-the-job training at industrial sites	1.8
Computer-aided instruction or simulation	3.0
Videotaped instruction	4.0
Mobile classroom/Lab	4.3

In response to a question about the effectiveness of cooperative teaching ventures between traditional vo-tech instructors and the following types of personnel, average ranking of the choices was as follows:

Cooperative Teaching	Rank
Industry personnel	1.6
Training consultants	2.7
University faculty and staff	3.4

Based on directors' replies, the most favored delivery system is very similar to the current method. That is, directors felt that schools should offer programs most suited to local industry, with close contact and cooperation between vo-tech teachers and industries that employ the school's graduates. It is expected that some on-the-job training would be conducted by industry after employment. Several directors commented, however, that their responses were based on current options and took into account limited resources and lack of a nearby industry training site.

On-the-job training after employment is a typical first choice for a system that trains skilled personnel for placement within the community. Several teachers have implemented a cooperative work experience program integrated with their curriculum, in which working students are still officially in the training program. Where a program of this type is available, it is strongly preferred by schools, industry, and students. Schools get realistic feedback on student skill levels while they are still in the program and deficiencies can be corrected. Industries see students in a realistic job setting before regular employment and can more easily select the most outstanding workers. Students are afforded the opportunity to experience a company's work setting before committing to employment.

Although computer-aided instruction and videotape courses were ranked low by the directors, this is largely due to inexperience with these methods and a strong belief in direct contact with students. High technology topics lend themselves well to these methods of instruction and could provide a lower cost alternative to upgrading all programs in all schools. Teachers expressed reluctance to use audiovisual programs exclusively because a good proportion of their students respond more quickly to personal guidance rather than self-study. However, the traditional videotape consists of a dry classroom lecture with shots either of a speaker or a set of notes. Professionally produced videotapes improve the effectiveness of this medium, and many are already available at reasonable cost. As noted by the directors, training should never rely on these methods alone. They should instead be part of a mix of training methods.

Using industry personnel as teachers can be an effective method of familiarizing students with the latest methods and equipment in their field. Many vo-tech teachers already use guest speakers and field trips to augment their curriculum. Several successful cooperative work experience or intern programs already exist in the state. Many other states actually hire part-time instructors from industry, although this stems primarily from a lack of qualified teachers. At this time, no mechanism exists within Georgia's vo-tech system to do this. It could, however, provide a solution to the shortage of qualified teachers and reduce the necessity for formal updating programs.

Directors were also asked what changes they feel would be necessary to upgrade their present high technology programs to state-of-the-art. Results are shown in Table 4-3.

Of the 28 schools with computer-related courses, the greatest concern appeared to be for skills updating for teachers and the inclusion of new material into programs. The new curriculum guide will fill much of this gap. Even though all the vo-tech schools recently received new Burroughs computers, some need was expressed concerning other equipment updating.

TABLE 4-3

VOCATIONAL-TECHNICAL SCHOOL DIRECTORS' EVALUATION OF CHANGES NECESSARY TO BRING HIGH TECHNOLOGY COURSES TO STATE-OF-THE-ART (PERCENTAGES)

High Technology Area	Number of Programs	Develop New Curriculum	Hire Qualified Teachers	Obtain Additional Funding	Update Skills	Add Courses	Eliminate Courses	Update Equipment
Computer-Related Technologies	28	50.0	19.2	42.3	53.9	46.2	7.7	38.5
Electronics Technology	23	52.2	13.0	65.2	73.9	65.2	21.7	73.9
Electromechanical Technology	12	58.3	33.3	58.3	58.3	58.3	16.7	75.0
Drafting Occupations	22	75.0	27.3	54.6	54.6	54.6	18.2	68.2
Mechanical Technology	10	50.0	40.0	90.0	80.0	60.0	30.0	90.0

In electronics technology courses offered at 25 schools, skills updating and the need for updated equipment were the most frequently cited needs. Due to rapid technological developments in this field, adding new course material was also a major concern. The need expressed for additional funding is, of course, related to directors' continuing concern regarding their schools' ability to produce highly qualified technicians in this high demand field.

Electromechanical technology, a newer program, is offered at 12 schools. Needs for a new curriculum and skills and equipment updating were expressed by vo-tech school directors. The new curriculum guide planned will offer further direction for the necessary updating of teacher skills.

Programs in various drafting occupations are offered at 24 schools. Some concern is expressed concerning the need for equipment updating, and new curricula particularly as a result of CAD (computer-aided design) systems. Industry presently has few complaints concerning graduates from these programs. Students know the basics, so industry generally completes the orientation to necessary equipment on-the-job.

Mechanical technology, including those machine shop programs considered high technology by school directors, are offered in only 10 schools. Updating teacher skills and equipment were of greatest concern to directors. Again, the need expressed for additional funding is related to continuing concerns regarding the ability to produce adequately trained technicians to meet anticipated industry demand.

In summary, strengthening curricula, updating teacher skills, and updating equipment were the greatest needs expressed by school directors in order to upgrade and/or maintain present high technology training programs. These items must remain high priority if the Georgia vocational-technical education system is to be competitive with that of other states.

SECTION V

APPROACHES TO SIMILAR PROBLEMS IN OTHER STATES

A. INTRODUCTION

Competition among states to attract and retain high technology industries is severe. Beyond the usual siting requirements (such as energy costs, quality of life, and favorable tax structure), high technology firms show most interest in those states which possess:

- o An existing base of high technology firms
- o A visible commitment by government to high technology
- o The ability to provide skilled technicians

For comparison, eight states were selected for investigation of their high technology training programs. As technical industry centers, California and Massachusetts are renowned for their high technology training experience. Geographically, Florida, North Carolina, and South Carolina are Georgia's greatest competition. Florida and North Carolina have well-established high technology resource centers, while South Carolina is in the process of implementing a major state plan for attracting high technology industry. Arkansas, Oregon, and Texas were selected for their innovative responses to industry training needs.

Appropriate individuals within the vocational-technical education system in each state were contacted. (See Appendix F for a list of contacts). A trained interviewer conducted a telephone interview with each person. In order to encourage comments on and discussion of a variety of subjects, many of which could not have been predicted, interviews were unstructured. A general outline, however, was followed in order to assure comparable data. Clarification of information and further questions also were completed by telephone.

For clarity in later discussion, a distinction between "junior colleges" and "community colleges" must be made. In general, junior colleges were originally designed to offer the first two years of a regular four-year college curriculum. Vocational-technical programs were added later.

Community colleges, however, were designed as a part of the local school system to offer courses and programs relevant to the community. Vocational-technical programs generally were an integral part of the concept from the beginning. Many states with an extensive community college system, such as California, do not have separate vocational-technical schools. The community colleges assume the functions of such schools.

This section first presents an overview of problems in common with other states and then discusses problems in each of the eight states individually.

B. PROBLEMS IN COMMON WITH OTHER STATES

1. Educational Structure

Like Georgia, many states have systems of educational governance that are divided among several authorities at different levels. Responsibility for the governance of vocational-technical programs is frequently split for secondary and post-secondary programs. Separate governance for post-secondary programs depending on type of institution, or governance shared by several bodies, also causes numerous problems.

When overall coordination of vocational-technical training is prevented or made difficult, program response capabilities are severely reduced. New courses or programs that are needed may be delayed. The revision of courses to reflect changes in industry and required skills may also be delayed. Communication among schools and with industry is much more difficult when a number of different agencies are involved. Since this communication is frequently a delicate matter, any significant barrier can potentially hinder or destroy it.

Duplication of courses, resources, and equipment can be another result of confused multi-authority governance. This includes overlapping subject matter between secondary and post-secondary courses. If curricula are coordinated, some students entering post-secondary training programs fresh from high school can successfully challenge courses. Thus, a larger number of qualified technicians can be graduated at a lower cost.

2. Program Offerings

Due to the ever-changing nature of high technology, industry needs cannot always be met immediately. A certain delay is inevitable. One industry criticism is the excessively slow response on the part of schools to new high technology areas. This may result from poor communication between schools and industry, but it may also be caused by the current delay involved in the development, testing, and approval of new curricula. Much more severe problems can be caused, however, by irrelevant or outdated training.

Irrelevant training may occur from a failure to determine the availability of employment for a particular skill. Lack of clear communication between industry and schools may also result in the inclusion of irrelevant skills. Outdated training, however, is more common. Slow curriculum changes may result from a lack of program coordination or lack of communication with industry. The use of outdated equipment and failure to keep instructors updated are problems far too frequently encountered.

A large number of students lack basic skills in math, science, and communications. If students entering post-secondary training can barely read and write and know only rudimentary mathematics, their educational inadequacies are virtually impossible to remedy in two years. Some success has been obtained by including these subjects in the training curriculum on a practical level. Changes in secondary school educational requirements must occur on a national level, however, before this problem is adequately solved.

Partially due to these problems, industry is requesting a method of pre-judging skills levels. Traditionally this has been handled by either local industry knowledge of the training curriculum or by awarding a certificate upon mastery of particular skills. Every state contacted during this study, however, now offers two-year associate degrees for high technology training, although not all states offer the degree at the vo-tech level. Most also have dropped or reduced general education requirements to reflect technical training needs. Table 5-1 presents data on high technology associate degree programs for states presently in competition with Georgia.

3. Teacher Updates

No state contacted has really solved the problem of updating high technology vocational-technical teachers. Traditional in-service education and seminars do not provide the specialized training necessary in these fast-moving fields. While some states are attempting to update their teachers through offering sabbaticals for industry work, logistics are difficult. Since most vo-tech teachers work year-round, little time is available. Funds for replacement teachers, if they can be found, are rarely available. Using part-time instructors from industry is another approach, but this also causes numerous problems. Little continuity within a department is possible, evaluation is especially difficult, and classes must frequently be scheduled at odd times to fit the instructor's regularly scheduled work hours.

Certification requirements for high technology vo-tech teachers have been modified or dropped in many of the states contacted during this study. Irrelevant certification requirements, particularly required education courses, annoy potential instructors. This is especially true when no pro-

TABLE 5-1
GENERAL EDUCATION REQUIREMENTS FOR ASSOCIATE DEGREES*
OFFERED IN VOCATIONAL-TECHNICAL FIELDS

STATE	CONFERS DEGREE			GENERAL EDUCATION REQUIREMENTS	COMMENTS
	Junior College	Community College	Vo-Tech School		
ALABAMA	•	-	•	"Satisfy requirements"	AAS and ATT degrees
ARKANSAS	-	•	•	8-10 hours	-
CALIFORNIA	-	•	none	18 hours	-
FLORIDA	-	•	•[1]	-	No state requirements
MASSACHUSETTS	-	•	•	-	No state requirements
MISSISSIPPI	•	-	none	15 hours	-
N. CAROLINA	-	•[2]	•	24-25 hours	-
OREGON	-	•	none	15-21 hours	Each community college sets own requirements
S. CAROLINA	•	-	•	12 hours	Diploma only from vo-tech school
TENNESSEE	-	•	•	-	No state requirements
TEXAS	-	•	none	12 hours	Same for any degree
VIRGINIA	-	•	none	5 hours	For AAS

*Includes Associate of Science (AS), Associate of Applied Science (AAS), Associate of Applied Technology (AAT), and any other technical associate degrees.

1/While all courses are taken at the vo-tech school, the degree officially is conferred by an associated community college.

2/Only community colleges can also offer the optional program for transfer to a four-year college.

vision is made for the continual updating necessary within high technology fields of study. Standards vital to maintaining high quality programs, however, must be preserved.

4. Industry/School Interface

The relationship between vocational-technical schools and industry can range from adversary to fully cooperative. After high technology companies in Massachusetts lobbied for Proposition 2-1/2, which has severely crippled the educational system, hostility towards industry was running high. Slowly, through advisory council assistance and cooperation from some high technology firms, the relationship is becoming more positive.

Oregon demonstrates the opposite process. After making a special effort to solicit industry needs and suggestions, the vocational-technical system has full cooperation from industry. Yet not much earlier, several companies had closed because the vo-tech schools were unable to provide enough qualified technicians in their field.

Given the chance, many firms would change vocational-technical programs into what would essentially be proprietary schools. The purpose and goals of technical schools and industry differ, and important educational objectives must be safeguarded. While most programs are at least partially successful, certain problems in communication frequently surface. A basic difference concerns short-term as opposed to long-term goals. Industry is profit-oriented and thus concerned with relatively short-term results, while schools must make long-range plans and are very cautious regarding change. High technology areas are volatile and available technology may be revolutionized overnight. Company personnel and policies necessarily reflect this. For these reasons, industry would prefer "flexible" training programs, similar to proprietary schools. Courses might last only a few days, be offered only once and dropped, or changed in midstream. Public schools on the other hand, are reluctant to change curricula to suit a particular company and fear that industry support could be unexpectedly terminated. Schools have formal procedures for curriculum development and change, which may require years of preparation.

A major frustration to schools in working with high technology industry is the rapid turnover of personnel. Just as basic agreement is being reached, the company contact changes. In fact, the most successful programs are those that have designated full-time personnel from industry and schools in order to maximize contact.

5. Teacher Salaries

Qualified instructors for high technology programs are very difficult to find and even more difficult to keep. Low salary levels are the worst problem. Industry salaries are so high and teacher salaries so low that instructors frequently cannot afford to continue teaching full-time. While a number of methods of managing this problem have been presented, no one method represents a real solution at this time.

6. Vo-Tech Image

Few problems are encountered regarding the current vocational-technical school image. Recent publicity concerning high technology training, jobs available for vo-tech school graduates, and the need for "hands-on" skills for future jobs have educated parents, students, educators, and industry about the quality of available programs. While an occasional problem may occur over a particular school or program, in general the image of vo-tech training will improve in proportion to the improvement of the program.

7. The Economy

With the exception of Texas, the present economy is having a negative effect on vo-tech programs, including high technology. The shortage of available funds mandates reliance on accurate and timely data for the planning of appropriate programs. This need will in all probability increase.

* * * * * * *

The following subsections discuss individual responses of the eight states' educational systems to high technology training needs and common problems.

Seven aspects of each state's vocational technical education system are examined. These are:

1. Educational Structure
2. Program Offerings
3. Teacher Updates
4. Industry/School Interface
5. Teacher Salaries
6. Vo-Tech Image
7. The Economy

Responses to these areas are summarized in Table 5-2 for the eight survey states and for Georgia.

C. ARKANSAS

1. Educational Structure - Arkansas

Overall governance of the Arkansas education system is provided by the State Board of Education, whose members are appointed by the governor. A Commission on Higher Education oversees community colleges, state colleges, and universities. The Department of Education, which oversees all other programs, is divided into two sections of equal authority. General Education is responsible for K-12, while Vocational-Technical Education is responsible for the coordination of all technical programs, from high school machine shop to community college two-year programs. On the state level, Vocational-Technical Education makes all decisions concerning which entity (university, college, community college, vocational-technical school, or

Table 5-2

SUMMARY OF RESPONSES BY EIGHT STATES AND GEORGIA
TO SEVEN ASPECTS OF VOCATIONAL-TECHNICAL TRAINING

	Educational Structural	High Technology Program Offerings	Teacher Updates	Industry/School Interface	Teacher Salaries	Vo-Tech Image	The Economy
ARKANSAS	Secondary and Post-secondary training is governed by the Dept. of Education's Vocational-Technical Section.	Technical associate degrees are offered in: Electronics Computer science Instrumentation And others	Certification is local and competency-based. Updating includes conferences and workshops.	Interface is provided by advisory boards, the Industry Training Program, and personnel exchange.	Special job slots at higher salaries were created by legislature. Part-time instructors from industry are often hired.	Image is being upgraded through education of guidance counselors and the public, and through interface with industry.	Arkansas is providing state funding to high tech programs but feels that this investment is wise.
CALIFORNIA	Post-Secondary vo-tech training is governed by the Board of Governors of the California Community College.	Technical associate degrees offered in: Electronics Computer Science Communications Alternative fuels And others	Certification is not required for part-time teachers most of whom are from industry.	Interface is demonstrated through a variety of advisory committees, equipment donations, and work programs.	California uses mainly part-time teachers from industry. Salaries are too low to attract good full time teachers.	Image is increasingly better due to state expenditures, innovative programs, and numerous job opportunities.	Proposition 13 has affected high tech programs, but more seriously affects secondary schools and future students.
FLORIDA	Post-secondary training is governed by the Board of Trustees and/or the local School District.	Technical two-year degrees are offered in: Computer science Laser optics And others	High tech instructors are judged on industry training and experience. Updating is provided on a state level but scheduled on a local level.	Advisory boards are very active, but many cooperative programs are plagued with problems.	Low teacher salaries make hiring and retaining high technology teachers extremely difficult.	Image is improving. Several new programs are exposing new students, teachers, guidance counselors and parents to vocational technical career opportunities.	The current economic situation is damaging high tech programs through loss of monies for equipment and teachers.
MASSACHUSETTS	Post-secondary training is governed by the Dept. of Education.	Technical associate degrees are offered in: Computer programming Computer services Computer repair And others	Staff development is conducted through industry, but does not allow continuous updating. Approval, not certification, is used for vo-tech teachers.	The Massachusetts Council for High Technology, a consortium of over 100 firms, has been highly successful in lobbying and curriculum development.	Due to Proposition 2-1/2, no money is available for upgrading salaries even in high technology areas.	Image has improved considerably among all target groups.	Because of the depressed economy, schools are planning no new programs and are having difficulty keeping what they have.
NORTH CAROLINA	Post-secondary training is governed by the State Board of Community Colleges.	Technical associate programs in: Chemical tech Electronics engineering technology Computer And others	No certification is required. Staff development is accomplished through industry updating programs and specialty conferences.	In addition to local interfacing, extensive efforts occur to increase industry/school cooperation on a state level.	Low salaries cause severe difficulties in recruitment. Although high tech teachers receive higher salaries than general teachers, salaries are still 30% to 50% less than industry.	Image has never been higher, resulting in legislative approval of the full expansion budget.	A strong financial commitment to high Technology has been repeatedly demonstrated. State officials feel the resultant influx of firms is a good return on their investment.

Table 5-2
(Cont'd)

	Educational Structural	High Technology Program Offerings	Teacher Updates	Industry/School Interface	Teacher Salaries	Vo-Tech Image	The Economy
OREGON	Post-secondary training is governed by the State Board of Education.	Technical associate degree programs are available in: Electronics Computer/computer services Laser optics, Spectrophysics technology And others.	No certification is required for post-secondary vo-tech teachers. No formal updating is required by the state, so most updating is an informal return to industry.	While schools are developing working relationships with local high industries, Regional Vocational Coordinators provide a larger framework of industry/school cooperation.	While using short term instructors for industry now, Oregon's goal is a free flow of personnel between industry and schools.	Image is good because the community college system was designed to serve post-secondary vocational needs.	The worsening economy is definitely hurting vo-tech training, with lack of equipment the worst problem.
SOUTH CAROLINA	Post-secondary programs are governed by the State Board of Comprehensive and Technical Education.	Five resource centers in existing schools are planned in: Computer applications Electronics Robotics Future office occupations Advanced machine shop	Certification procedures do not affect technical instructors. Staff development is handled through industry seminars and conferences.	Interfacing is encouraged through active Advisory Boards, personnel exchange, and cooperative internships.	Unable to raise low teacher salaries presently, South Carolina hopes to attract teachers through interest in the "Design for the Eighties" Concept.	As a result of hard work by vo-tech schools, image has increased considerably in the past five years.	Funds to implement the five resource centers are "on hold" until interest rates go down.
TEXAS	Secondary and Post-secondary training programs are governed by the State Board of Education.	Two-year degrees offered in: Alternative energy Computer applications Electronics Laser/optics Communications	Credentialing replaces certification. Updating is accomplished through specialized workshops at both local and state levels.	All interfacing takes place at a local level. Cooperative internships are most prominent.	Teacher salaries have been raised considerably but high technology instructors still may make 50% less than they would in industry.	Image is generally good, particularly for post-secondary programs.	Texas is unique in that their economy is booming. Thus high tech programs are expanding rapidly.
GEORGIA	Secondary and post-secondary programs in vo-tech schools are governed by the Department of Education. Training at Junior Colleges are governed by the Board of Regents.	Programs available in: Computer tech Drafting Electrical tech Electro-mechanical Industrial electronics Instrumentation tech Machine & tool design Machine shop Mechanical tech	Certification requirements are the same as those for secondary teachers, including 30 hours of education courses in the first 3 years. A new emphasis on staff development for high tech teachers is shown through special in-service conferences, programs, and state regional seminars.	State and local advisory councils provide guidance while the High Technology Coordinator will provide overall interface. Locally cooperation includes work experience programs for updating teachers. Equipment donations and joint programs are expected to increase	Low teacher salaries act as a severe barrier to high tech implementation.	Traditionally viewed as "trade schools", Georgia's vo-tech schools are quickly gaining credibility due to recent improvements and recognition of present high technology program achievements.	The poor economy is not affecting Georgia as badly as other states, but economies are still very necessary. High technology programs were recently awarded $8.0 million to upgrade electronics, mechanical, and electromechanical programs.

Industry Training Program) is best suited to fulfill a particular industry training need. This central coordination prevents the duplication of offerings and restricts new training programs to those with a demonstrated employment need.

The Arkansas Industry Training Program (ITP) is a separately funded entity within Vocational-Technical Education. In order to allow complete flexibility, the program receives no federal funds and is thus accountable only to the state. With a staff of eight, the program is geared directly to industry training and employment needs.

All requests by local high technology firms for technical workers are received by the Industry Training Program. These requests range from an immediate need for one or two specialized technicians to a long-range request for a specific training program. If at least ten full-time positions for a specific skill are to be created within two years, a two-year associate degree program can be developed. Immediate personnel needs of high tech firms are satisfied by a job search conducted by the Program. Costs, including those of newspaper advertisements placed in areas most likely to have the required type of worker available, are borne by ITP. This program, similar to Georgia's QUICKSTART, fulfills new and expanding high tech industry needs. Thus, a continual working relationship is maintained with all of the state's high technology industries.

2. Program Offerings - Arkansas

Arkansas presently offers high technology courses in a variety of areas, primarily electronics and computer science. All of these are offered as two-year associate degree programs, with earlier exits available. Degrees are conferred by one university, several community colleges, and all vocational-technical schools. Course work for the associate of science degree includes few nontechnical course requirements.

Two new courses have recently been added -- Instrumentation Technology, which replaces Industrial Maintenance, and Electromechanical Technology.

Both are offered through community colleges and are geared towards a two-year associate degree. In order to keep these courses open to the entire population, many of whom do not desire or could not complete a two-year course, five earlier "exit points" are available. For example, in the Electromechanical Technology course, a basic electronics certificate can be obtained in three months of study. This training qualifies a student for electronic assembly-line work. Other exit points qualify a student for progressively more advanced work.

3. Teacher Updates - Arkansas

Certification and recertification of high technology instructors is competency-based. Both the instructor and the school administration assess classroom performance and demonstrated knowledge and skill in the subject area. Formally, this process is handled on a local level.

Staff development for high technology instructors is not appreciably different from other technical staff development. Special conferences, workshops, and seminars are presented, but since most of the high technology instructors either teach part-time while employed in their field or only for a short period, the need for updating in specific skills areas is not as critical as otherwise would be the case.

4. Industry/School Interface - Arkansas

Arkansas presently has both a State Advisory Board and the local curriculum advisory boards mandated by the federal government. Due to the difficulty of getting representatives from varied sectors of industry, most local boards are not considered effective. Arkansas is expecting the Reagan Administration to drop the requirement for advisory boards, at which time many local boards will be discontinued.

Most interface with industry is on a local level, through individual instructor/company contacts rather than through the advisory boards.

Personnel exchange between schools and industry and even between schools (universities and vo-tech schools) is largely informal. Specific training programs are presented for various industries, either in the appropriate educational facility or in the plant. A sliding scale determines cost to the industry, but instructors' salaries are usually paid by the company. At the same time, a university professor or an industry expert may be brought into a vo-tech course, where the cost is borne by the school.

Some cooperative internships exist in the high technology programs, but these are still new. Plans are to expand these programs as continuing relationships between individual schools and industries grow.

5. <u>Teacher Salaries - Arkansas</u>

The large discrepancy between educational salaries and industry salaries has led Arkansas to an innovative method of competing with industry for high technology instructors. The state legislature has created 48 employment slots outside the ordinary salary structure and mandated that these slots be used only to maintain qualified high technology instructors. Half of these slots are at $25,000 and half at $29,000, although salaries are entirely discretionary and no salary limit was placed on an individual slot. Using part-time or temporary employment of industry experts, up to 150 high technology instructors might come into this category. Since this is outside the regular structure, tenure is not a problem and knowledge of and experience in a specific field become the primary qualifications. Fifteen of these job slots are presently in use. While turnover is high, Arkansas reports no difficulty in finding qualified high tech instructors for all its courses.

6. <u>Vo-Tech Image - Arkansas</u>

Some problems still exist with the vocational-technical image. Guidance counselors, and thus students, do not as yet fully appreciate the opportunities available, particularly in high technology fields. There are also some misunderstandings concerning aptitudes and abilities (such as abstract reasoning) necessary to the successful completion of high technology programs. While avoiding "tracking," Arkansas expects that its vocational-technical schools should get 10% to 20% of high school graduates, and guidance counselors are now being instructed concerning opportunities in these fields.

Educators in general, however, "see the handwriting on the wall" regarding future employment opportunities. Students seem to share this recognition. College enrollment last year dropped by 6%, while vocational-technical program enrollment rose 12%.

Industry appears to be generally pleased with the results of the vo-tech programs, but are requesting more remedial math and English. Arkansas is now spending $3.5 million a year on special remedial programs.

7. <u>The Economy - Arkansas</u>

Presently, Arkansas is putting $1 to $1.5 million a year into new vocational-technical programs. New high technology programs are budgeted at about $450,000 each, with most of the expenditures in equipment. Discretionary funds are also available for equipment, if necessary. Including maintenance and replacement of equipment, high tech training programs are each estimated to require $100,000 a year after implementation. A well-coordinated inventory system is already in place to assure continual updating of the equipment now in use. The almost $1.3 million for high-technology instructor slots has already been mentioned.

While the cost of their commitment to attracting high technology industry is high, Arkansas feels that additional jobs and an expanded tax-base are the likely rewards.

D. CALIFORNIA

1. Educational Structure - California

The California educational system is governed by four separate boards. Responsibility for K-12 and adult education belongs to the State Department of Education. The 107 public community colleges are governed by the Board of Governors of the California Community College system. Governance of the state college system is provided by the Board of Trustees for State Colleges, while universities are governed by the Board of Regents of the University System.

In California, community colleges provide the necessary trained technicians for industry. These schools offer career development, skills improvement and job retraining programs, as well as a wide range of academic courses. Programs are offered during convenient hours at the community colleges and, when appropriate, at industry locations.

Until 1968, the Department of Education governed community colleges. At that time the Board of Governors and the Chancellor's office, the administrative arm of the Board, were created to provide better response to post-secondary education needs.

2. Program Offerings - California

High technology firms are common throughout California, but many of the state's electronics firms are concentrated in the Silicon Valley. Santa Clara Valley in northern Santa Clara County is the home of the first semiconductor manufacturers. Due to the rapid growth of the electronics industry there, the area became known as the Silicon Valley, after the silicon chip. Training in electronics is most advanced in Silicon Valley, but is available at most community colleges. Computer training programs are widely available, including specialties such as computer-aided drafting. While new, communications processing is blossoming. In order to provide future technicians for alternative fuels, a number of programs are now being developed in this growing specialization.

Associate degrees are offered in all of these programs, although earlier exit points are also available. Degrees are granted by the community colleges and typically require only 18 units of general education (one course each from natural science, social science, humanities and fine arts, and English composition). The remainder of the average 60 units required for an A.S. degree are in specific technical areas.

3. Teacher Updates - California

Partially due to the extreme shortage of qualified applicants for high technology teaching positions, many of California's programs rely on part-time "moonlighters" from industry. Updating is no problem when instructors are working daily with state-of-the-art technology. These personnel do present problems, however, in necessitating massive temporary hiring efforts and in difficulties related to evaluating performance. While instructors from industry can offer advice to keep curriculum current, the lack of regular faculty can disrupt the regular activities of an entire department. Updating for full-time faculty is mainly taking place in industry. Special programs assist in coordinating this temporary industrial experience for teachers.

Certification requirements in California depend on both experience and education. Regular faculty may be required to complete up to 30 quarter hours of education courses, but this does not affect part-time faculty. Once certified and thus able to teach, no recertification of vocational-technical teachers is required.

4. Industry/School Interface - California

Because the earliest electronics firms first concentrated in California, community colleges in the Silicon Valley have the most extensive experience with high technology training. Dr. Elizabeth Useem, Associate Professor of Sociology of Boston State College, conducted an extensive study of the industry/school interface in the Silicon Valley (Education and High Technology Industry: The Case of the Silicon Valley, Boston State College, Boston, MA, August 1981). Her report presents a comprehensive view of industry and educational views of high technology training programs in this area. All six of the community colleges in the valley offer two-year high technology training programs. Cooperation between industry and schools, particularly with the community colleges, is evident in a variety of advisory committees, equipment donations, and cooperative programs. At the same time, experience in presenting high technology training has also clarified certain problems.

In 1979, the $25 million California Worksite Education and Training Act (CWETA) was passed in response to complaints from the electronics industry that community colleges were not meeting their training needs. The act requires that the Division of Apprenticeship Standards, the Employment Development Department, community colleges, and the State Department of Education work together to provide the funding, technical assistance, and classroom instruction necessary to provide technical training. Employers identify specific skills necessary to entry level employment, and community colleges then develop the training programs to meet those needs.

CWETA is designed to provide training to unemployed and lower level workers for entry level positions and promotion. Community colleges provide relevant training, while industries provide facilities, release time for employees to attend classes, and jobs or promotions upon successful completion of training. Under the act, "allowable expenses" are reimbursable for companies participating in the skills upgrading training. These include costs incurred for training supervision, maintenance of training records, and other administrative expenses. Lost production time is also reimbursable.

Called "too little, too late" by industry and education alike, the program has been severely criticized for excessive bureaucracy. Even more serious, when economic growth slowed, some companies lost interest in the program because of the guaranteed job requirement. Still, schools and industry do cooperate in a number of ways. Many companies donate state-of-the-art equipment to programs or permit classes to use company equipment at the plant site. Companies may encourage personnel exchange, particularly for teaching or planning activities. For example, a full-time Bell Telephone officer presently is on loan to San Mateo College to work with 17 other firms utilizing advanced communications equipment to develop programs in this field. Some firms allow workers time off to attend classes resulting in a two-year degree. Upon completion of training, workers are generally promoted. For the convenience of employees, community colleges frequently present courses at particular companies. If open to the public, training is paid entirely by the school. In the case of "contract courses" designed strictly for company personnel, the company pays.

5. Teacher Salaries - California

California has experienced some difficulties with finding qualified teachers for the high technology courses due to low teacher salaries. While not entirely solving the problem, reliance on part-time teachers from industry has permitted excellent programs to develop and continue. Occasionally, a particular industry or company provides full salary support for a teacher in a selected program.

6. Vo-Tech Image - California

California's vocational-technical education image has improved greatly since the Governor began providing active support. A new program, the Governor's Investment in People, is still before the State legislature. Designed to improve technical education from kindergarten through college, this program specifies that community colleges receive $10 million of its $49 million budget. Since California expects a tax shortfall of $2 to $3 billion this year, some delay is expected. Most California vo-tech programs have a good image with both industry and students. High technology programs in particular attract good students.

7. The Economy - California

Proposition 13 has not hit community colleges as severely as it has secondary schools, but it still affects program expansion as well as the updating of present courses, particularly equipment expenditures. High technology industry does recognize that these budgetary constraints are preventing the community colleges from providing enough trained technicians for their needs. California housing costs almost preclude attracting employees from other areas, so more emphasis is now being placed on retraining local workers and further developing present employees.

State government in California has demonstrated significant support for high technology. While criticized, CWETA does provide $25 million for high technology training. Some CWETA programs, such as a $2.5 million electronics program sponsored by the College of San Mateo, are highly successful. In addition, $2.6 million has recently been allocated by the California legislature to build a microelectronics center (MICRO) at the University of California at Berkeley. An additional $1 million has been earmarked for research. These expenditures are expected to attract new high technology companies and aid in efforts to retain those already present. Additional technicians needed by these companies will continue to be provided by the community college vocational-technical system.

E. FLORIDA

1. Educational Structure - Florida

Each of Florida's 67 counties is a separate school district with responsibility for programs in K-12 and post-secondary vocational-technical schools. While the 28 community colleges also offer some vocational-technical courses, they are governed by a separate Board of Trustees. Minimum requirements for the content of each vocational-technical course are prescribed by the state, but in general, the school district makes all program decisions for vocational-technical schools. The Board of Trustees provides some statewide coordination for community college programs, but local control is a strong tradition.

2. Program Offerings - Florida

Florida has offered high technology training in laser optics for almost four years. Training in both manufacturing and service has been very successful. A new program in robotics is starting soon to provide training for an incoming firm. All manufacturing and service personnel will be trained by the state for initial employment. If demand justifies it, a regular two-year course will be initiated.

In planning for the further development of high technology courses, Florida is concentrating high cost technology programs at centers located close to related industries. Life-long retraining for these occupations is being built into the program matrix from the beginning. Coordination of course content is also being planned to ensure transferability between schools.

Associate degrees are offered for present high technology courses and planned for future areas. All associate degrees are granted by community colleges. Some vocational-technical centers provide all training at the vo-tech school, but the degree is still granted through the community college. In addition to the associate degree, earlier exit points leading to a certificate are available.

Rather than the usual general education requirements for an associate degree, academic courses for an associate of science degree are more practical. Technical writing rather than basic English composition and on-the-job practical math and physics provide exactly the skills most necessary to employers.

In an innovative cooperative training program, advanced students are matched with a professional. For example, an engineering technology student might be assigned to an engineer and receive training by monitoring a research project and writing up the technical results. While presently a merit program, plans are to expand this internship program into minority training.

3. Teacher Updates - Florida

Keeping vocational-technical teachers current is a difficult problem. Funds for staff development are allocated by the legislature and disseminated by the established staff development system. Offerings are developed on the state level, but local school districts schedule their teachers. Industry experts are generally invited by the state office to present updated information in particular specialties through one- or two-day seminars. In this way, programs reach many more teachers than was previously possible, and updating is uniform within specialties.

While the state sets general certification/recertification standards, community colleges are permitted to use local standards if they wish. This does not pose any problem, however, in high technology programs. These instructors are judged primarily on industry training and experience.

4. Industry/School Interface - Florida

Advisory committees operate on both the state and local level. Committees for each vocational-technical discipline are active on a state level, and each school district and community college has its own general advisory committee. In addition, practically every program has a specific advisory group. Some areas, such as food service, are beginning to combine related advisory committees.

In the past few years, Florida has been experimenting with personnel exchange programs. While some programs have been locally successful, many have been plagued with problems. Since most vocational-technical teachers work twelve months a year, finding the time for returning to industry is difficult. In addition, industries sometimes balk at paying a technical teacher to experience a variety of jobs.

Student apprenticeship programs also have shown mixed success. While popular and of unquestionable value, some educators feel that students need more varied experiences during the program. Since many students are paid during this period, employers sometimes treat participants more like employees than students.

State vocational-technical officials feel that most of these problems can be solved by closer working relationships with industry. Twelve economic development meetings were recently held around Florida specifically to encourage interfacing with business and industry. Feedback was excellent, so many of these problems may yet be resolved.

5. Teacher Salaries - Florida

Low teacher salaries make hiring and retaining qualified vocational-technical teachers extremely difficult. This problem is intensified in high technology areas. Florida does use experience to raise salary levels several steps, but this is still inadequate. While teacher salaries are higher in South Florida, industry salaries also are higher and consequently the effect is lost. Partial salary support for certain high technology teachers has been offered by industry. Unfortunately, Florida teacher unions will not permit this option.

6. Vo-Tech Image - Florida

While the image of vocational-technical education has improved greatly in the past ten years, some problems still exist. Students are generally unaware of the wide range of opportunities available unless they have been exposed to them through friends or family. To correct this deficiency, new exploratory programs have been introduced in Florida's junior high and middle schools. Because students have been exposed to available offerings, high school vocational-technical enrollment has already increased.

A related problem is a lack of understanding of vocational-technical training opportunities by parents, particularly minority parents. A new program is now underway to work with parents, explaining job ladders, and this program is already beginning to have effect.

Vocational-technical programs in Florida have lately gained considerable status, especially among school administrators. Guidance counselors, however, have difficulty understanding the many vocational-technical programs available, particularly in high technology fields. Florida is now working with guidance counselors and vocational-technical teachers, training them to assess student abilities properly, including abstract-thinking and problem-solving abilities necessary to high technology.

Florida industry appears pleased with vo-tech graduates and has been increasing its interest in vocational-technical programs. Companies from as far away as Michigan have donated equipment to various schools. Economic development meetings have stimulated additional interest in industry/vo-tech school interfacing, so further progress is expected.

7. The Economy - Florida

Florida expects the current economic situation to damage vocational-technical programs. Federal money has traditionally been used for experimental programs, such as specialized high technology courses. As funds are cut, expensive equipment necessary to many high technology programs will be difficult to finance, even with industry donations. Problems in recruiting qualified instructors, particularly in high technology fields, are expected to worsen. Vo-tech officials have expressed hope that avionics training money will soon be available from the military, so that avionics technician programs can be expanded.

F. MASSACHUSETTS

1. Educational Structure - Massachusetts

Two boards provide governance to the Massachusetts educational system. The Board of Regents oversees all community colleges, state colleges, and state universities. The State Board of Education is responsible for K-12 and, through the State Department of Education, oversees all post-secondary programs of two years or less. Thus, the State Board of Education governs most vocational-technical education programs.

2. Program Offerings - Massachusetts

Due to its high concentration of companies in the computer field, Massachusetts is focusing training efforts towards various aspects of computer technology. Associate degrees in computer science are awarded by the community college system and one regional vocational-technical school. Particularly in the vo-tech school, programs are concentrating on technical aspects, with a concurrent de-emphasis on liberal arts.

While a profound shift to technology has occurred within the vocational-technical system, no new programs are planned. Presently, the minicomputer industry is one of the few viable industries in the state. Tax ceilings similar to California's Proposition 13 have jeopardized the educational system in general. Massachusetts has severely reduced staff at every level of education and, in fact, now has the second highest number of laid-off teachers in the country. Many of these teachers are themselves now students training as technicians for the computer field.

3. Teacher Updates - Massachusetts

Staff development within the vo-tech field is primarily conducted through programs which send teachers back to industry for updating. These programs have been reasonably successful, but do not provide the opportunities necessary for continuous updating in high technology fields.

Certification and recertification requirements are dictated by the Department of Education and most typically affect primary and secondary teachers. Approval, a separate procedure, is used for vocational-technical teachers. In this way, experience in the specialty area is taken into account along with academic achievement.

4. Industry/School Interface - Massachusetts

While local advisory boards assist each school, the most far-reaching industry/school interfacing has occurred through the private Massachusetts Council for High Technology. A consortium of over 100 Massachusetts high technology firms, the Council has been highly successful in lobbying for vocational-technical legislation and assisting in the development of high technology curricula.

Most frustrating to the Massachusetts vocational-technical system is what is seen as an overall negative attitude right now toward education. When the tax revolt was at its height in Massachusetts, many high technology companies lobbied heavily for Proposition 2-1/2, which passed in 1981. Massachusetts schools are still attempting to recover from the first effects of severe budget cuts caused by this tax ceiling. Educators state that some high technology companies, though relatively few, now recognize the danger of the resultant lower quality of future employees.

In the meantime, vocational-technical programs are attempting to develop closer relationships with industry. Hopefully, partnerships will evolve, allowing further expansion of student internships, faculty personnel exchange programs, and equipment loans and donations.

5. Teacher Salaries - Massachusetts

With Proposition 2-1/2 decimating the ranks of teachers, the problem of low salaries has not been as evident as in the past. Most teachers who can get a job in industry, however, particularly at a higher salary, will leave teaching. At this point, absolutely no money is available for upgrading salaries, even in the high technology areas.

6. Vo-Tech Image - Massachusetts

The image of vocational-technical training has improved considerably among all segments of the population. In the past seven to eight years, 26 new vocational-technical facilities have been opened. Long waiting lists demonstrate high interest on the part of students. As illustrated by the Massachusetts Council for High Technology, industry is playing an increasing role in vo-tech education and appears pleased with results so far. School officials throughout the state support vo-tech programs, particularly in high technology, because "that's where the jobs are."

7. The Economy - Massachusetts

Even high technology companies in Massachusetts are feeling the crunch as a result of the depressed economy. Schools are planning no new programs and are having great difficulty retaining present ones. Equipment for various programs is now being requested from industry. As for expanding present programs, educators feel that companies may not be realistically projecting employment needs and fear that graduates would have to go out-of-state to find work.

At least for now, no one in Massachusetts feels that things will get better soon. Within vocational-technical education, concentration is on keeping present programs going.

G. NORTH CAROLINA

1. Educational Structure - North Carolina

Governance of North Carolina's educational system is provided by three separate boards. The State Department of Education is responsible for programs K-12, while higher education is governed by the Board of Governors of the University System. Since 1981, governance of the community college system has been provided by the State Board of Community Colleges. Under its direction, the Department of Community Colleges administers the system. In turn, a local Board of Trustees administers each community college. Until 1981, the State Board of Education governed both secondary and post-secondary vocational programs. They now fall under the new State Board of Community Colleges.

2. Program Offerings - North Carolina

High technology offerings in North Carolina include two-year degree programs in chemical technology, electronics engineering technology, and a variety of programs in computer/computer services. In the field of robotics, a new program in computer numerical control (programming of industrial robots) will begin in the fall of 1982. Curricula already have been designed for programs in both biotechnology and semiconductor technology for implementation when demand justifies it.

All 58 schools (23 community colleges, 35 technical institutions) offer associate of science degrees. While community colleges do provide programs allowing transfer to the university system, high technology programs are more technical. Of the 96 quarter hours required for an associate of science degree, only 18 hours of English, social sciences, or humanities are required. Emphasis instead is on technical writing, math, physics, and topics directly related to job performance.

3. Teacher Updates - North Carolina

Staff development for vocational-technical teachers is accomplished through updating of programs by industry and specialty conferences and seminars. Although teachers are generally paid by industry while they are being updated, the resultant loss of teaching time has been a problem for schools. Because of this problem, North Carolina is considering a new leave policy that allows funding of replacement teachers while instructors update their skills. Due to the specialized nature of vocational-technical courses, conferences and seminars are conducted by specialty, and far less emphasis is placed on attendance at general education in-service programs. While teachers have no difficulty taking time to attend these programs, opportunities may not be frequent enough to keep skills honed.

No state teacher certification is required to teach vocational-technical courses. When an instructor is brought in from industry, however, a course in teaching methods is required, resulting in a vocational-technical teaching certificate.

4. Industry/School Interface - North Carolina

As required for federal funding, every program at each institution has a local advisory committee of business and industry in the field. While liaison with industry is primarily on an individual/local basis, programs have been working well. For example, last year occupational upgrading was provided for 275,000 employees.

On the state level, a staff of seven industrial specialists work with industry and vo-tech programs throughout the state. In addition, the Governor's Council on Management and Development, consisting of leaders of industry appointed from the state's largest employers, assists in lobbying for vocational-technical education and also acts as a state-level advisory board. Governor Hunt declared 1981 the "year of the community college" and concentrated on educational/industry interfacing.

While the on-the-job cooperative training program is only six months old, it has been so successful that 15 centers have implemented it. Because it is an informal arrangement between schools and industry, the Department of Labor is not involved. The program provides some classroom training, with the remainder taking place on-the-job. So far, employers are very pleased with the program's results.

In an effort to attract microelectronics and related industries, North Carolina is planning a $30 million Microelectronics Center to be built at Research Triangle Park. The Center will initially cost the state $24.4 million. An additional $6 million will be raised during the first two years through federal sources, foundations, and industry support. As the microelectronics industry outgrows the Silicon Valley area in California, North Carolina hopes that this Center will help attract firms to North Carolina.

The proposed Center has already paid off. In August 1980 the General Electric Company announced the siting of a $50 million microlectronics operation at Research Triangle Park. GE's Vice Chairman, Edwart Hoot, stated, "a key factor in the selection of North Carolina was its microelectronics program with a state center in the Raleigh-Durham area."

5. Teacher Salaries - North Carolina

Low teacher salaries and resultant difficulties in recruiting and retaining qualified high technology teachers pose a severe problem. North Carolina's educational system is decentralized, so salaries are totally the option of local schools. High technology instructors generally receive significantly higher salaries than general education teachers, but still are paid 30% to 50% less than industry scale.

An unusual solution to this problem has been suggested by a technical education official. Industry might be induced not only to allow employees to teach part-time, but to provide salary support for these teaching duties. North Carolina is investigating the possibility of tax credits for a program of this type.

6. Vo-Tech Image - North Carolina

While some problems linger from the past image of vocational-technical education, legislature-watchers feel that the program's credibility has "never been higher." As a result, the Department of Community Colleges was the only state agency to get legislative approval of 100% of its expansion budget.

Student interest in high technology training is high, but the general low level of technical literacy of high school graduates is a serious problem. In a follow-up of vocational-technical training effectiveness, employers' criticisms focused on the lack of basic skills, particularly math and English. While remedial programs are available, they are not part of the regular vocational-technical training. Thus, many students must spend extra time preparing for entry into a high technology training area. A public relations program has been initiated to help increase basic skills levels by increasing motivation.

7. The Economy - North Carolina

North Carolina has demonstrated its strong commitment to high technology by its further development of Research Triangle Park and its strong support for training. The Department of Community Colleges recently received full funding ($2.2 million each year for the 1982-1983 biennium) for 30 critical needs programs. These include:

- Electronics Engineering Technology
- Industrial Maintenance Technology
- Instrumentation Technology
- Industrial and Maintenance Electromechanical Technology
- Electronic Data Processing

Fifteen cooperative skills training centers were also funded for $1.8 million. These centers are designed to respond to particular needs of industry.

In North Carolina's plan to stabilize its economy by attracting more diversified industry, state support of high quality training programs is seen as paramount. This investment is paying off in new industry, new jobs, and an expanded tax base.

H. OREGON

1. Educational Structure - Oregon

Two boards govern Oregon's educational system. Members of the State Board for Higher Education are appointed by the governor to oversee the college and university system. The State Board of Education, whose members are also appointed by the governor, oversee all other aspects of the educational system through an elected supervisor. Local school boards then govern their respective schools, including K-12 and community colleges. Since all post-secondary vocational-technical education takes place in the community colleges, high technology training falls under the governance of the State Board of Education.

The Educational Coordinating Commission, whose members are appointed by the governor, makes overall policy recommendations. If a significant duplication or conflict occurs between programs in the community colleges and higher education, the Commission has authority to resolve the problem. Otherwise, its function is strictly to review and prepare policy recommendations.

2. Program Offerings - Oregon

Oregon's high technology industrial base is just emerging, so most programs are still in the planning stages. Community colleges are increasingly focusing on high technology training programs. Since the community college system in Oregon is only 20 years old, it is still highly flexible. That flexibility can be seen in programs such as a joint community college/CETA microprocessor training program. A local chemical plant supervisor was trained as an instructor for 600 CETA participants in a program based at the community college.

Most of Oregon's high technology training programs are in electronics, particularly silicon chip production. Various computer programs are becoming increasingly significant and are expected to expand. A program in spectro-physics technology is available at one of the largest community colleges.

In the future, the major focus will be on updating workers to reflect technological changes in industry. For example, two community colleges will soon offer programs in fishery technology. Using the only simulator of its kind in the country, students will be trained to use sophisticated electronics equipment now found on major fishing vessels. Half the students in the program will be employed fisherman taking courses for retraining.

All of Oregon's high technology programs are two-year associate degree programs, although earlier certificate exit points are available in most of them. Each community college sets its own requirements for general education credits, with a range of 15 to 21 hours.

Increasing emphasis on technical training with a concurrent decrease in general education requirements will soon allow even associate degree programs to be scheduled without regard to the academic year. This will permit greater flexibility in course content, particularly in joint development of programs with industry.

3. Teacher Updates - Oregon

No formal updating is required at the state level for any instructor at a community college. Staff development is handled locally, although a few statewide special projects are emerging. Programs for vocational-technical teachers emphasize a return to industry for updating.

No state certification is required for post-secondary vocational-technical teachers. Each community college determines its own academic and experiential requirements. This flexibility makes it easier for community colleges to judge potential teachers by their knowledge and experience in the field based on specific course content.

4. <u>Industry/School Interface - Oregon</u>

Each community college has a local advisory board for each vocational-technical program. No state level advisory board exists, but the State Director of Vocational Education attempts to reflect industry input in course content. All program approvals and new curriculum development are the responsibility of the Director of Vocational Education.

Little is presently being done to effect personnel exchange between industry and vocational-technical programs, though it is expected that this exchange will increase, particularly for high technology programs. Direct contract training for industry by community colleges is already increasing. Arrangements for training are handled strictly at the local level, frequently involving close working relationships between vo-tech teachers and industry personnel.

The area with greatest contact and cooperation, however, is cooperative work experience. While programs vary, one of the larger community colleges has 2,000 students presently participating in a cooperative work experience program. Vocational-technical students account for 60% of this total. Almost 200 of these are from high technology training areas.

While the work experience program is accredited, arrangements with employers are informal. Companies new to the co-op work experience program are frequently reluctant at first, particularly since the student is required to experience a variety of jobs and must be paid. (Due to the poor economy, some co-op students are performing volunteer services for the experience alone, but at present this does not affect high technology areas.) After participating in even one cooperative training venture, however, most companies are enthusiastic. Students are formally evaluated at the end of every term, and almost always are rated "above average" or "excellent." The program's success is reflected in the fact that 70% of the students are offered permanent jobs at the end of their work experience, most with their work experience employer.

High technology companies are not yet as active in the cooperative work experience program as traditional companies are. Participation will increase as the community colleges work more closely with these new industries.

One major problem, however, is that high technology industries examine schools to be assured that proper training is available, but do not yet work with the school to develop training curricula. On the other hand, some Oregon educators feel that many high technology jobs are assembly-line positions unsuitable for their two-year students.

While the community college system is still developing working relationships with local high tech industries, Regional Vocational Coordinators (one for each of the 15 State Education Service Districts) already have implemented several successful programs interfacing schools and high technology industries.

Oregon educators went directly to high technology industry and asked exactly what companies needed in terms of training and how these needs could be met. A wealth of ideas came forth, including methods of improving interfacing. Companies are already enthusiastically implementing many of these.

Oregon has already lost some small high technology firms because these firms could not compete with large companies for the limited number of qualified technicians. Industry is thus very conscious of the need for technically oriented students to expand the labor pool. One new program involves several industries that work with junior high schools to introduce students to electronics with actual hands-on experience. Basic electronics skills are presented, along with an emphasis on the practical need for science, math, and communications skills.

On the high school level, another company will be team-teaching electronics, math, science, and technical writing in a model program. Even career day experiences in electronics have been expanded, with generous donations of equipment and supplies from industry.

Another company is planning to circulate a monthly newsletter concerning the electronics industry aimed at community college instructors. All concerned feel that this continuing exposure will greatly assist instructors in staying abreast of new developments at minimal cost to both industry and schools.

In discussions between schools and industry, three separate "tracks" have been identified for high school students interested in electronics careers. First, those student heading towards entry-level and manufacturing jobs can be trained using independent learning systems. Second, students preparing for the community college technical programs need training and experience with tools, assembly skills, programming, and so on. Third, students going on to electronics engineering programs need the same types of basic skills experience, as well as an even heavier background in math and science.

In order to provide the number of skilled workers the electronics industry requires, training will be coordinated between high schools and community colleges. Articulation programs, where students can challenge community college courses based on knowledge and experience gained in secondary courses, are now being developed. In this way, an increased number of students meeting current skill standards can be produced without placing an increased burden on the community colleges in terms of space, staff, and equipment.

Further meetings between high technology industries and school officials are planned. A major issue to be addressed is the problem of poor basic skills in math, science, and communications. Education officials expect their relationship with industry to improve even more as a result of these meetings.

5. Teacher Salaries - Oregon

Qualified high school and community college technical instructors are increasingly difficult to attract due to the tremendous differential between salaries for teachers and industry personnel. Oregon is approaching the problem by hiring short-term instructors from industry. A free flow of personnel between industry and schools is Oregon's goal.

6. Vo-Tech Image - Oregon

The vocational-technical image in Oregon is reasonably good because the community college system was designed from the beginning to serve post-secondary vocational needs. Students are very interested in vocational-technical training, and there is certainly no shortage of students in high technology areas.

Educators are generally well disposed towards technical training programs. High school principals, however, are being forced to cut programs and frequently choose to cut vocational-technical programs due to their relative high cost. Industry has shown tremendous interest in improving both the number and quality of technical graduates. Particular emphasis is being placed on early training in basic skills and working with schools to present opportunities for early training experiences.

7. The Economy - Oregon

The worsening economy is definitely hurting vocational-technical training in Oregon. State appropriations for vocational education are not specifically earmarked, but come to community colleges based on full-time equivalent students in approved programs. No problems have yet occurred, but the potential for problems is great. Federal funds are specifically directed to vo-tech, but are expected to be severely cut.

Equipment represents the worst problem. At the same time that operating budgets are being cut, Oregon's program equipment is becoming outdated. Oregon has the third highest unemployment rate in the nation, so its decreased ability to train future workers is especially ominous. High school programs are in the same dire straits. At least part of the answer, Oregon feels, is in a closer working relationship with industry. While vocational-technical training is "in for a dry period," innovative programs formed out of necessity are already showing results better than those projected for them.

I. SOUTH CAROLINA

1. Educational Structure - South Carolina

Three boards govern South Carolina's educational system. The Commission on Higher Education, primarily a planning board, coordinates all state institutions of higher learning. Primary, secondary, and adult vocational programs are governed by the State Board of Education, while the State Board of Comprehensive and Technical Education is responsible for all state-supported technical institutions. Thus, the State Board of Comprehensive and Technical Education governs all post-secondary diploma and associate degree programs in vocational-technical and occupational areas that are financed wholly or in part by the state. The Board recently hired a Director of Innovative Training specifically to handle high technology training needs.

2. Program Offerings - South Carolina

South Carolina is meeting the challenge of high technology training through comprehensive planning. Adopted by the state legislature in 1979, the "Design for the the Eighties" concept is to establish five resource centers in existing technical schools throughout South Carolina in:

- o Computer Applications
- o Electronics
- o Robotics

- Future Office Occupations
- Advanced Machine Tool Technology

All resource centers are now designated and training has been completed for center directors and other key personnel. Some equipment is in place, but the $1.75 million in bond money for further equipment has been frozen by the budget control board due to high interest rates. It is hoped that interest rates will decline and the funds for equipment will be available by the end of the fiscal year.

3. Teacher Updates - South Carolina

Staff development for high technology instructors is handled primarily by attendance at industry seminars and conferences. Instructors utilize industry for skills updating, either in a special "return to industry" program or by attendance at in-service training programs designed for industry personnel. Certification procedures do not affect technical instructors because they are not governed by the State Department of Education.

4. Industry/School Interface - South Carolina

Advisory Committees are very active on both a state and local level. In addition to expanded career day activities to make the public as well as students aware of career opportunities, industries have donated equipment to various programs.

Personnel exchange programs have not been as successful as hoped due to salary differentials. But cooperative internships have been highly successful. In fact, the need for trained technicians is so great that companies are now hiring many students prior to entry into the program. Industry then pays tuition costs for the student to take skills courses part-time, while also working part-time. Industry is upgrading increasing numbers of employees in this way as well.

5. Teacher Salaries - South Carolina

Particularly in the high technology areas, low teacher salaries are a severe problem. With the present poor economic situation, South Carolina is relying on attracting qualified teachers through interest in the "Design for the Eighties" concept.

6. Vo-Tech Image - South Carolina

The image of vocational-technical education in South Carolina has improved over the past 10 years as a result of efforts by the schools. Good vocational programs in secondary schools attract many students. Potential job opportunities have stimulated interest in post-secondary technical programs, particularly in high technolgy.

Educators in general support vocational-technical programs, again partially in response to economic realities. Industry is highly enthusiastic, because the need for well-trained technicians is critical.

7. The Economy - South Carolina

General funding for high technology training is presently based on the same formula as traditional vocational-technical programs. However, this is now in the process of changing to the more suitable higher education formula. As indicated earlier, high interest rates on bonds are preventing implementation of South Carolina's plan for five high technology resource centers. Until these funds are released, South Carolina's new high technology training programs will remain "on hold."

J. TEXAS

1. Educational Structure - Texas

Governance of the Texas educational system is the responsibility of two separate entities. The State college and university system is governed by the Coordinating Board, while K-12 and vocational-technical education are the responsibility of the State Board of Education. While a separate Division of Post-Secondary Vocational Programs exists to coordinate and oversee programs in 66 institutions, it is located in an office dominated by and oriented toward secondary education. Of the 950 staff members (previously 1,100) of the State Board of Education, 12 are concerned with post-secondary education. Inevitably, specialized problems are not always understood.

2. <u>Program Offerings - Texas</u>

Texas offers a variety of high technology programs including:

- o Alternative Energy Sources
- o Computer Business Applications
- o Computer-Aided Drafting
- o Industrial Maintenance
- o Laser Optics
- o Microelectronics (primarily maintenance)
- o Precision Optics
- o Satellite Communications

The bulk of these programs offer two-year associate degrees. Those students who either must or want to begin work earlier have the option to begin work after the first year and complete training over several years. Each new program proposed is reviewed by the State Board of Education, the Division of Post-Secondary Programs, and the Department of Occupational Education and Technology.

While more than half of the hours towards the associate of science degree must be in specified core courses, the only liberal arts requirements are 6 hours of history and 6 hours of government. Even these may soon be dropped as requirements for the technical degree. Most high technology programs concentrate on physics, math, and technical communications skills for "elective" credits. A study is now under way to determine the effectiveness of this approach.

3. Teacher Updates - Texas

Staff development programs may be provided either by the local school district or by the state. Larger school districts have a full-time staff development person who presents programs during school breaks and for a few days during the summer. Small school districts may rely entirely on programs developed by the state with federal funds.

Presentations are generally workshops emphasizing practical content for a specific technical area. Eighteen separate workshops are scheduled this year. Frequency is determined by the need for updating. Data processing workshops are held every year due to rapid changes in technology, while air conditioning and cooling workshops may be held every five years. In order to ensure state-of-the-art presentations, industry is brought in to make presentations of the most recent advances.

No formal certification is required for post-secondary vocational-technical teachers. Instead, teachers must be granted credentials through the Office of Post-Secondary Vocational Programs. The credentials process examines education, work experience outside the field of education, and teaching experience.

4. Industry/School Interface - Texas

An Advisory Board with a minimum of five industry representatives is required for each program at each institution. All interfacing between industry and schools takes place entirely on the local level. Personnel exchange programs are not presently widespread.

Cooperative internships, however, are considered a component of regular programs. While optional, field experience is available for all programs.

5. Teacher Salaries - Texas

While teaching salaries in general for Texas have been below national scale in the past, they are now in the mid-range. Some salaries went up 17% to 18% last year alone. The state legislature has been very generous with education, particularly post-secondary vocational-technical programs. Salaries for vocational-technical teachers are presently above the national average and are expected to be considerably above average next year. Recruiting and retaining qualified high technology teachers is still a severe problem, however, because industry is paying such high salaries. For example, a computer technology instructor could make $23,000 to $25,000 as a teacher, while industry would pay $35,000 or more.

Since teaching salaries might be as much as 50% less than industry, many instructors teach only part-time while working full-time in industry. Because of this problem, many courses must be scheduled at night.

In areas in which many qualified instructors have been lost due to low salaries, industry will sometimes fund a chair. These funds are added to the regular teaching salary, but may not prove stable.

6. Vo-Tech Image - Texas

While a few "archaic" programs are slow to change, the vocational-technical education image in Texas is generally good. This is particularly true for post-secondary programs. Educators are accepting changes in course content and areas of specialization very well. Guidance counselors for the vocational-technical program schools have developed excellent relations with their feeder high schools. Thus students have easy access to current information on available programs and career options.

Beginning six to eight years ago, students entering vocational-technical programs were older (an average age of 28), more serious, and more knowledgeable about career opportunities. Many enroll part-time at community colleges in order to stay abreast in their field or to prepare for a career change.

Industry definitely supports the vo-tech programs, particularly in high technology. In fact, companies hiring students prior to their completion of the two-year program has become a problem.

7. The Economy - Texas

Texas is unique, at least among the states contacted for this study, in that its economy is booming. Officials state that they have no economic problems and will be expanding their high cost, high technology programs. Although teacher salaries are not equal to those in industry, tremendous increases are being given.

The economic boom is largely petroleum-based, and this explains the one failure in terms of student placement we have encountered. For the last few years, several two-year degree programs in alternative energy have been producing graduates. While it was logical to assume a growing need for this type of program consistent with national projections, graduates cannot find jobs in Texas due to slow acceptance of any substitute for oil. This experience confirms the importance of including current local employment data in vocational-technical education planning.

SECTION VI

FINDINGS, NEEDS, AND RECOMMENDATIONS

A. INTRODUCTION

An analysis of the information gathered in the course of this project leads to the identification of needs throughout the vo-tech school system and recommendations on how best to meet those needs. In this final section of the report, the findings on high technology trends in industry, the skills required by current and emerging high technology industry, and the barriers hindering the meeting of those requirements are summarized. The needs of the vo-tech school system are then presented in the areas of programs, delivery systems, equipment, and staff. Finally, recommendations for the effective implementation of a well-directed statewide high technology program are presented, addressing system needs, program needs, and staff needs.

B. FINDINGS

1. High Technology Trends

High technology industrial areas most likely to have a major impact on Georgia's economic development with implications for the training of technicians are:

NEAR TERM	MID TERM	LONG TERM
Computer Services		
Computer Manufacturing	Laser Technology	Unknown
Communications		
Avionics		

In addition, the effects of industrial automation should be monitored very closely in the near term for retraining opportunities. Biotechnology and solar energy are not projected to have major impact; however, advances in these areas could change the employment outlook and should be monitored on a regular basis.

2. High Technology Skills

A list of typical skills required to support current high technology firms in Georgia is presented in Table 6-1. For the most part, these skills are not manipulative but cognitive. The vo-tech graduates of today and tomorrow will require a broader, more fundamental understanding of their fields with the ability to solve problems or troubleshoot in areas to which they were not specifically exposed during their years in school.

Skills required by industries with mid-term and long-term impact are more difficult to predict because of the innovative and changing nature of high technology. Equipment will become more complex, requiring more highly skilled technicians for maintenance if not for operation. Computer and electronics applications will begin to pervade all aspects of our society. Laser applications in industrial processes and energy generation may become commonplace; in fact, many of these applications are now commercially available with strong growth rates predicted through 1990. Biotechnology breakthroughs and the economic feasibility of solar energy will no doubt change the skills required of vo-tech graduates, but it is too early to tell in what manner. In all probability, however, the emphasis on cognitive skills versus manipulative skills will be required throughout the remainder of this century.

3. Barriers

Discussions with industry training personnel, school directors, and high technology administrators in other states pointed out the following major barriers to implementation of effective high technology programs in vo-tech schools:

TABLE 6-1

SELECTED LIST OF BASIC SKILLS DEMANDED OF TECHNICIANS IN HIGH TECHNOLOGY FIRMS

1. Skill in the selection and proper use of precision electronics instrumentation, including oscilloscopes, digital voltmeters, etc.
2. Skill in assembling and troubleshooting printed circuits, wiring, and other electonic components.
3. Basic knowledge of electricity, electronics, and electronic circuits.
4. Ability to read and understand wiring diagrams, schematics, and technical specifications.
5. Skill in machine tool set up and operation, including machines equipped with CNC devices.
6. Ability to prepare logs, charts, and technical reports.
7. Understanding of shop mathematics.
8. Ability to use handbooks and chart formulas.
9. Comprehensive knowledge of electronic test theory.
10. Knowledge of structures and materials as they relate to the job.
11. Basic knowledge of hydraulics and mechanics.
12. Knowledge in geometry, trigonometry, and other related mathematical tools.
13. Knowledge in basic engineering technologies.
14. Ability to write technical reports and present technical concepts orally.

ALL

Lack of up-to-date equipment
Inadequate teacher updating
Quality of students

INDUSTRY	SCHOOLS
Basic skills not taught	Low teacher salaries
Slow response to needs	Competition with industry for teachers
	Funding/the economy

In addition, 96% of the Georgia school directors perceived certification requirements as a major barrier, and 62% cited lack of leadership at the state level.

C. NEEDS

1. Programs

Comparing industry comments on skill deficiencies of current vo-tech graduates with the current programs and curriculum guides used by Georgia teachers shows that many of the deficiencies are due not to the lack of understanding by teachers of what is needed but rather to the lack of instructor updating and equipment. Deficiencies reported most often were lack of basic electronic skills, knowledge of Boolean algebra, microprocessor interfacing, and hands-on experience with the latest equipment. The current programs in Electronics Technology, Electromechanical Technology, and Mechanical Technology are reasonably well-suited to providing these skills required by industry. A modular approach where fundamentals are taught in the first five or six quarters with specialization in the last few quarters would provide a more flexible program; changes in technology would necessitate only a revamping of the the last few modules. For example, an electronics program would provide courses such as electronics fundamentals, basic circuits, and microprocessor fundamentals in the first phases, with typical specializations in the last phase of industrial electronics, computer applications, communications, or avionics depending on what the student was interested in or what jobs were projected to be available at his or her graduation.

One curriculum area that has been lacking but is now projected for inclusion into the associate degree pilot program is general education skills--math, physics, and technical writing. Need for these courses stems from the emphasis on cognitive versus manipulative skills mentioned earlier.

Accreditation Board for Engineering Technology (ABET) requirements include a minimum of 100 quarter hours with 50 hours in technical areas, 25 hours in basic science and math, and 14 hours in communication, humanities, and social sciences. According to the Preliminary Curriculum Planning Guide for engineering technology programs (1982) prepared by Georgia State University and the Center for Occupational Research and Development, heavy emphasis will be placed on laboratory contact hours.

Mid term and long term program needs will need to be closely coordinated with industry as projected trends evolve into bonafide employment opportunities. Industrial automation and laser technology are deemed significant enough to begin now in formulating an approach to program offerings. Gathering materials and setting up a framework so these would be ready to implement on a year's notice could help attract new industry to the state or be enough impetus to an existing industry to revamp their production processes. There is some risk involved in setting up a program before actual jobs are established. However, it is a risk that should be considered in order to meet high technology industry needs of the future.

2. Delivery Systems

New delivery systems need not be developed for teaching high technology. No one "best" delivery system emerged from this study. Instead, the major concern is how to locate delivery systems to best satisfy the needs within cost constraints. Student skills, subject area, and teacher preference impact the choice of delivery system. But overall cost and demand should be the major decision factors in developing individual delivery systems at the school level.

Laboratory simulation, OJT (on-the-job training), and classroom lectures are preferred by vo-tech educators because of the students' needs for interactive reinforcement. Videotape and other audiovisual media are preferred by industry where students are more experienced and subject areas more specialized.

As far as the "basic skills" curricula and instrumentation are concerned, a permanent program at every school is needed. However, with regard to teaching more specific job training skills, the programs should be taught only in those schools at which a definable need exists. Equipment to support these programs should be permanently installed at schools with high enrollments, and a time-sharing arrangement should be utilized at schools with lighter enrollment.

Mobile laboratories, while cumbersome to manage and schedule, provide an opportunity to share expensive equipment across the state, thereby helping to hold down overall costs. Industry facility usage represents an attractive substitute for mobile, time-sharing use of state equipment, assuming local industries will cooperate in making their facilities available for such training. Off-campus programs at industrial sites, while typically the least expensive, require scheduling at odd hours and will likely encounter resistance on the part of industries because of the high cost of maintenance resulting from inexperienced operator use of machinery.

Table 6-2 displays the recommended delivery system combinations appropriate to each of the three fundamental training programs scheduled for upgrading: Electronics, Electromechanical, and Mechanical Technology.

TABLE 6-2

RECOMMENDED DELIVERY SYSTEMS

TECHNIQUE	COMMENTS
Electronics	
Preferred: Classroom instruction augmented by lectures, laboratory simulators, and OJT. All schools fully equipped for programs offered.	The fact that electronics is the heart of high technology and that few, if any, equipment items are big ticket (< $100,000), suggest all Vo-Tech schools should eventually be fully equipped with analytical and instructional electronic equipment. True, some will become outdated, but many will have long lives (5-10 years). This cost can be offset by extending part of the teaching load to instructors provided by industry and by seeking industry and federal support. All other aspects appear feasible from industry response except funding.
Options: Same as preferred without fully equipped programs in all schools.	This option would reflect an inability to fully fund equipment purchases. It has a lower cost but also weakens the image and effectiveness of the entire system.
Same as preferred but with equipment sharing among schools.	In the case of electronics equipment, sharing equipment is a poor choice. Most instrumentation is delicate and vulnerable to theft.
Electromechanical	
Preferred: Classroom instruction augmented by lectures, laboratory simulators, and OJT. Many schools fully equipped, with marginal programs (from an attendance perspective) sharing industrial equipment.	Electromechanical technology approaches an area where overall equipment expense can be quite high. Furthermore, electromechanical equipment can get quite specialized. While the other aspects of delivery do not need to differ from the electronics approach, using industry equipment on-site coupled with Vo-Tech trainers should offer the most cost effective delivery of this program.
Options: Same as preferred except with mobile facilities to share high cost items among schools.	Logical solution where industry equipment is non-existent or unavailable. However, there are costs and risk associated with transporting equipment around the state. This option, therefore, is not very attractive.
Same as preferred except with select schools being outfitted with equipment items made available to other schools who can transport students to facilities for training.	Alternative to above but with problems of its own in terms of operating cost and scheduling. However, this option would be less costly than the one above.
Mechanical	
Preferred: Classroom instruction augmented by lectures, laboratory simulators, and OJT. Many schools fully equipped, with marginal programs (from an attendance perspective) sharing industrial equipment.	Mechanical training in such areas as machine tooling, casting, etc., require substantial capital outlay in equipment. Fortunately, this technology has not changed as substantially as the electronics area. Consequently, much of the existing equipment can be expected to remain up-to-date for years to come; and, therefore, more schools have a chance to have equipped programs. Nonetheless, industry augmentation of areas where school equipment is outdated is the lowest cost method of rounding out a training program.
Options: Same as electromechanical above.	Same as electromechanical above.

3. Equipment

The top four industrial areas predicted to have significant impact on Georgia in the near term have one common element: electronics. It is therefore appropriate to upgrade electronics equipment in all existing programs. Presented in Appendix G is a list of training equipment considered a basic mininum requirement for Electronics Technology. Costs would run about $100,000 per school. Also in Appendix G is a representative list of training equipment that would be required for state-of-the-art programs such as those being implemented in the three pilot schools. Costs would run an additional $260,000 per school.

Addressing the needs for industrial automation would require upgrading equipment in Mechanical and Electromechanical Technology programs. Equipment needs for basic minimum and state-of-the-art Mechanical Technology programs, also listed in Appendix G, are approximately $390,000 and $370,000, respectively, per school. Electromechanical Technology equipment costs would be $460,000 for a basic level program and an additional $243,000 for the pilot level program. However, there is some duplication of equipment because it is a hybrid of the Electronics and Mechanical Technology programs. Costs are summarized in Tables 6-3 and 6-4.

4. Staff

There is a critical shortage of qualified teachers to support key high technology courses. This shortage seems to be the result of teachers being both underpaid and overworked. Vo-tech teachers in the Georgia education system often have highly marketable skills which place them in high demand by industry. Accordingly, they command a high salary in the marketplace. Yet teachers in the vo-tech system are paid very low salaries in proportion to their market worth. A significant annual increase in supplemental wages paid to high technology teachers would be required to raise existing average salaries to the range competitive with industry. System constraints frequently prevent salary adjustment; consequently, it is difficult to attract and retain qualified teachers.

TABLE 6-3

BASIC LEVEL TEACHING EQUIPMENT

	Totals
ELECTRONICS TECHNOLOGY	
Segment A - Electronics Fundamental & Passive Components	$ 26,700
B - Basic Circuits & Active Devices	15,430
C - Integrated Circuits, Digital and Microprocessor Fundamentals, A/D & D/A Conversion Techniques	57,320
	$ 99,450
ELECTRO MECHANICAL TECHNOLOGY	
Segment A - Mathematics, Science & Drafting Fundamentals	$104,000
B - Basic Electricity, Electronics & Computer Programming	52,600
C - Motor Controls, Metal Working & Industrial Electronics Applications	308,300
	$464,900
MECHANICAL TECHNOLOGY	
Segment A - Mathematics, Science & Drafting Fundamentals	$104,000
B - Computer Programming & Basic Electricity	39,800
C - Metal Working and Fluid Controls	245,000
	$388,800

TABLE 6-4

PILOT LEVEL TEACHING EQUIPMENT

	Totals
Electronics Technology	$260,360
Electromechanical Technology	242,000
Mechanical Technology	370,000
	$873,360

NOTE: These are lists of suggested equipment considered to be a minimum requirement to carrying out basic and pilot level programs.

Higher salaries alone, however, will not provide a strong teaching staff. Currently, teachers spend an average of 30 hours per week in teaching and counseling duties. Since this leaves very little time for instructors to keep up-to-date with changes in their respective fields, a mechanism for allowing teachers more time for industry interaction is required. Periodic leaves of absence would provide vo-tech staff with the opportunity to work in an appropriate industrial setting, thereby familiarizing themselves with new equipment and technological changes.

High technology by definition is dynamic and ever-changing, and high technology teachers require frequent exposure to refresher courses on the latest developments. A recommended training center for high technology vo-tech school teachers could provide special training in high technology areas by both educational and industrial personnel. This training should be designed to complement vo-tech teacher training presently offered by the University of Georgia and Georgia State University.

The major activity at this center should be the development and provision of specialized short courses aimed at upgrading or refreshing the knowledge and skills of teachers in the high technology fields. Emphasis should be on those fields with substantial current and projected needs for skilled technicians. Courses should be presented at times convenient to vo-tech teachers and provide intensive technical theory and practical applications.

Training center facilities should include laboratories for hands-on training, classroom and conference areas, sophisticated media equipment, and a library housing an extensive and constantly updated data collection.

D. RECOMMENDATIONS

Recommendations designed to facilitate effective implementation of high technology programs by meeting system needs, program needs, and staff needs are presented in the following pages. Due to the rapidly changing nature of high technology, these recommendations emphasize the need for continual updating of a flexible and systematic plan rather than designating specific steps according to a rigid time line.

1. System Needs

ISSUE: Of numerous siting requirements expressed by high technology industries, ability of a state's vocational-technical school system to train quality technicians is of primary importance. Quality education is the result of good planning, which in turn results from accurate and timely analysis of relevant conditions and data. Because of the rapid changes inherent in high technology fields, the necessity for continual information and analysis is even greater.

RECOMMENDATION: Establish a group to provide continual strategic intelligence on high technology trends as support to the High Technology Advisory Council. Areas should include:

- **Projected job openings in various high technology fields**
- **Projected training needs**
- **Technical developments, both new and successfully implemented**
- **Specific curriculum updating needs**
- **Specific teacher update needs**

ISSUE: High technology training programs must respond quickly to: changes in training needs due to technological advances, new occupations, and the disappearance of specific skills or entire fields. This requires complete program coordination, from high school vo-tech courses to associate degree programs, and the ability to adjust program offerings quickly and efficiently.

RECOMMENDATION: Study Georgia's system of governance to determine the most effective means of providing governance to vocational-technical education efforts, particularly in high technology areas. Utilize the High Technology Training Coordinator as a liaison to ensure continual contact and cooperation among all concerned with the provision of quality technical training.

ISSUE: A cooperative relationship between schools and industry is necessary for communication of training needs and capabilities. A High Technology Advisory Council has already been formed, but can provide even greater assistance by actively participating in efforts to coordinate the state governing bodies, intelligence system, curriculum development committees, high technology industry and schools.

RECOMMENDATION: Encourage industry involvement in the training process through statewide or local:

- **Assistance in curriculum development**
- **Donation or loan of state-of-the-art equipment**
- **Exchange of personnel between schools and industry**
- **Development of cooperative work experience programs**
- **Funding of a high technology training "chair" or position in the vo-tech school**
- **Involvement in expanded "career day" activities**
- **Formation of programs to encourage mastery of basic skills (math, science, communications) in lower grades**

2. Program Needs

ISSUE: Program offerings in high technology fields are particularly vulnerable to obsolescence. Need for one skill may diminish while demand for an entirely new skill evolves due to technological advances.

RECOMMENDATION: Update program curricula based on information provided by the intelligence gathering group. Investigate curriculum needs based on long range forecasts and develop programs based on mid range forecasts so that capability to train can be used as a selling point in attracting new industry to the state.

ISSUE: The high technology technicians of today require more problem-solving abilities because of the rapid changes taking place. They must be able to adapt their knowledge to new situations. This places greater emphasis on cognitive skills rather than the manipulative skills traditionally taught by vo-tech schools and requires a more in-depth understanding of math and science fundamentals. Although the Interim Report recommended that two-year degrees be implemented over the long term, more immediate action has been taken by the State Board of Education. The accelerated development and implementation of a two-year degree program in high technology areas should not ignore the need to secure the support and co-operation from industry, accrediting agencies, and other appropriate organizations.

RECOMMENDATION: Set up a formal arrangement between the State Board of Education and The Board of Regents to cover the granting of two-year technical associate degrees.

ISSUE: An innovative training approach represents a vital, flexible training system. Continually changing training needs, availability of funds, and varying levels of industry involvement require constant monitoring and response. Data on these aspects and potential methods of addressing specialized needs will be supplied by the previously mentioned intelligence group.

RECOMMENDATION: Develop an innovative training approach to address established needs by offering:

- **Courses at various hours, including evening, late night, weekend or split work/school schedules**
- **Courses at convenient locations, based on local conditions**
- **Programs with more cooperative work experience than usual or more concentration on basic skills**
- **A statewide placement service for the convenience of both industry and students**

ISSUE: In order to fulfill the need for technicians in high technology industry, retraining programs must also be offered. Several programs in other states have demonstrated sucessful high tech training programs for unemployed workers. Also industrial automation will necessitate the establishment of systematic retraining programs so current employees can be updated on new techniques and/or equipment.

RECOMMENDATION: Provide opportunities for retraining to both the unemployed and currently employed workers needing updating. Establish a structure and develop annual plans for implementing the programs.

ISSUE: In order to be completely trained as high technology technicians, students must have access to state-of-the-art equipment. The $8 million appropriation is a needed boost. However, options must be put in place now to deal with equipment shortages in the future.

RECOMMENDATION: Implement procedures to furnish student access to state-of-the-art equipment through:

- **Systematic purchase plans**
- **Statewide or regional equipment pools**
- **Lease of equipment**
- **Solicitation of industry-donated equipment**
- **Use of equipment in industry through special arrangement for classes**
- **Use of equipment in industry through cooperative work experience programs**

3. Staff Needs

ISSUE: Continual updating of teachers' knowledge and skills is necessary to provide high quality, relevant training programs.

RECOMMENDATION: Establish a central training center to provide a variety of updating opportunities for high technology teachers including:

- **Workshops, seminars, and conferences**
- **Short-term updating in industry**
- **Shared personnel between schools and industry**
- **Distribution of publications concerning technical advances, new training equipment, skills necessary to use state-of-the-art equipment, and educational opportunities**

ISSUE: Qualified vocational-technical teachers are extremely difficult to find, and this is particularly true of high technology teachers. Low teaching salaries are the major impediment. Industry personnel in high technology fields must take a substantial pay cut in order to teach.

RECOMMENDATION: Implement the following options to provide higher salaries and incentives to attract high technology teachers:

- Legislature creation and funding of special job slots
- Full or partial salary support by industry of either chairs or individuals
- Personnel sharing with industry

ISSUE: If high technology teachers are to stay updated in their profession, they must spend a significant amount of time keeping abreast of new developments in their field.

RECOMMENDATION: Revise certification/recertification requirements to reflect specialty updating requirements for high technology teachers. Institute appropriate requirements for part-time teachers from industry. Reduce the teaching load from 30 hours per week for full time teachers.

Appendix A

VO-TECH SCHOOLS OFFERING HIGH TECH PROGRAMS

Post-Secondary Vocational-Technical Schools

With High Technology Programs

Albany Area Vo-Tech School, Albany
Athens Area Vo-Tech School, Athens
Atlanta Area Vo-Tech School, Atlanta
Augusta Area Vo-Tech School, Augusta
Bainbridge Junior College, Bainbridge
Ben Hill - Irwin Area Vo-Tech School, Fitzgerald
Brunswick Junior College, Brunswick
Carroll County Area Vo-Tech School, Carrollton
Columbus Area Vo-Tech School, Columbus
Coosa Valley Area Vo-Tech School, Rome
Dalton Junior College, Dalton
DeKalb Area Vo-Tech School, Clarkston
Griffin - Spalding County Area Vo-Tech, Griffin
Houston Vocational Center, Warner Robbins
Lanier Area Vo-Tech School, Oakwood (Gainesville)
Macon Area Vo-Tech School, Macon
Marietta-Cobb Area Vo-Tech School, Marietta
Moultrie Area Vo-Tech School
North Georgia Tech & Vo-Tech School, Clarksville
Pickens County Area Vo-Tech School, Jasper
Savannah Area Vo-Tech School, Savannah
South Georgia Tech & Vo-Tech School, Americus
Swainsboro Area Vo-Tech School, Swainsboro
Thomas Area Vo-Tech School, Thomasville
Troup County Area Vo-Tech School, LaGrange
Upson County Area Vo-Tech School, Thomaston
Valdosta Area Vo-Tech School, Valdosta
Walker County Area Vo-Tech School, Rock Spring
Waycross - Ware County Area Vo-Tech School, Waycross

Appendix B

MANUFACTURING COMPONENT OF WORK FORCE

MANUFACTURING COMPONENT OF WORK FORCE

In order to estimate the need for workers of a particular type it is necessary to establish the relationship between "total employment" and "production employment." To accomplish this task, five local high technology firms were surveyed and the percentage distribution of their work forces were determined. The values were averaged and rounded down to the nearest five percent. The resulting average was rounded to the nearest percent and subtracted, leaving the percentage of the manufacturing work force. Technologist and technician are positions that may be filled by persons who complete vocational education training programs. The five firms surveyed and the percentage of their manufacturing work force is as follows:

1. Intelligent Systems Corporation, a medium-sized manufacturer of color graphic devices, has 65% of its work force in manufacturing.

2. Western Electric Atlanta Works, a very large manufacturer of wire and optic cable, has 78% of its work force in manufacturing.

3. Lockheed Aircraft, a large assembler of aircraft, including structures, electronics and avionics, has 85% of its work force in manufacturing.

4. Marconi Avionics Incorporated, a medium-sized manufacturer of avionics devices, has 78% of its work force in manufacturing.

5. Scientific Atlanta, a large manufacturer of communication devices, has 83% of its work force in manufacturing.

The average of these five values was 77.8%, which renders 75% when rounded to the next lowest 5% value. Of this 75%, 5% was assumed to be the percentage of college-trained engineers and was subtracted from the total, thus leaving an average of 70% of the work force defined as production workers.

Appendix C

ENGINEERING AND SCIENTIFIC TECHNICIANS

Engineering and Science Technicians

Nature of the Work

Knowledge of science, mathematics, industrial machinery, and technical processes enables engineering and science technicians to work in all phases of business and government, from research and design to manufacturing, sales, and customer service. Although their jobs are more limited in scope and more practically oriented than those of engineers or scientists, technicians often apply the theoretical knowledge developed by engineers and scientists to actual situations. Technicians frequently use complex electronic and mechanical instruments, experimental laboratory equipment, and drafting instruments. Almost all technicians described in this statement must be able to use technical handbooks and calculators, and some must work with computers.

In research and development, one of the largest areas of employment, technicians set up experiments and calculate the results sometimes with the aid of computers. They also assist engineers and scientists in developing experimental equipment and models by making drawings and sketches and, frequently, by doing routine design work.

In production, technicians usually follow the plans and general directions of engineers and scientists, but often without close supervision. They may prepare specifications for materials, devise tests to insure product quality, or study ways to improve the efficiency of an operation. They often supervise production workers to make sure they follow prescribed plans and procedures. As a product is built, technicians check to see that specifications are followed, keep engineers and scientists informed on progress, and investigate production problems.

As sales workers or field representatives for manufacturers, technicians give advice on installation and maintenance of complex machinery, and may write specifications and technical manuals. (See statement on technical writers elsewhere in the *Handbook*.)

Technicians may work in engineering, physical science, or life science. Within these general fields, job titles may describe the level (biological aide or biological technician), duties (quality control technician or time study analyst), or area of work (mechanical, electrical, or chemical).

An engineering technician might work in any of the following areas:

Aeronautical Technology. Technicians in this area work with engineers and scientists to design and produce aircraft, rockets, guided missiles, and spacecraft. Many aid engineers in preparing design layouts and models of structures, control systems, or equipment installations by collecting information, making computations, and performing laboratory tests. For example, a technician might estimate weight factors, centers of gravity, and other items affecting load capacity of an airplane or missile. Other technicians prepare or check drawings for technical accuracy, practicability, and economy.

Aeronautical technicians frequently work as manufacturers' field service representatives, serving as the link between their company and the military services, commerical airlines, and other customers. Technicians also prepare technical information for instruction manuals, bulletins, catalogs, and other literature. (See statements on aerospace engineers, airplane mechanics, and occupations in aircraft, missile, and spacecraft manufacturing elsewhere in the *Handbook*.)

Air-Conditioning, Heating, and Refrigeration Technology. Air-conditioning, heating, and refrigeration technicians design, manufacture, sell, and service equipment to regulate interior temperatures. Technicians in this field often specialize in one area, such as refrigeration, and sometimes in a particular type of activity, such as research and development.

When working for firms that manufacture temperature-controlling equipment, technicians generally work in research and engineering departments, where they assist engineers and scientists in the design and testing of new equipment or production methods. For example, a technician may construct an experimental model to test its durability and operating characteristics. Technicians also work as sales workers for equipment manufacturers or dealers, and must be able to supply engineering firms and other contractors that design and install systems with information on installation, maintenance, operating costs, and the performance specifications of the equipment. Other technicians work for contractors, where they help design and prepare installation instructions for air-conditioning, heating, or refrigeration systems. Still others, in customer service, are responsible for supervising the installation and maintenance of equipment. (See statement on refrigeration and air-conditioning mechanics elswhere in the *Handbook*.)

Civil Engineering Technology. Technicians in this area assist civil engineers in planning, designing, and constructing highways, bridges, dams, and other structures. They often specialize in one area, such as highway or structural technology. During the planning stage, they estimate cost, prepare specifications for materials, or participate in surveying, drafting, or designing. Once construction begins, they assist the contractor or superintendent in scheduling construction activities or inspecting the work to assure conformance to blueprints and specifications. (See statements on civil engineers, drafters, and surveyors elsewhere in the *Handbook*.)

Electronics Technology. Technicians in this field develop, manufacture, and service electronic equipment and systems. The types of equipment range from radio, radar, sonar, and television to industrial and medical measuring or control devices, navigational equipment, and computers. Because the field is so broad, technicians often specialize in one area, such as automatic control devices or electronic amplifiers. Furthermore, technological advancement is constantly opening up new areas of work such as integrated circuit technology.

When working in design, production, or customer service, electronic technicians use sophisticated measuring and diagnostic devices to test, adjust, and repair equipment. In many cases, they must understand the field in which the electronic device is being used. To design equipment for space exploration, for example, they must consider the need for minimum weight and volume and maximum resistance to shock, extreme temperature, and pressure. Some electronics technicians also work in technical sales, while others work in the radio and television broadcasting industry. (See statements on broadcast technicians and occupations in radio and television broadcasting elsewhere in the *Handbook*.)

Industrial Production Technology. Technicians in this area, usually called industrial or production technicians, assist industrial engineers on problems involving the efficient use of personnel, materials, and machines to produce goods and services. They prepare layouts of machinery and equipment, plan the flow of work, make statistical studies, and analyze production costs. Industrial technicians also conduct time and motion studies (analyze the time and movements a worker needs to accomplish a task) to improve the production methods and procedures in manufacturing plants.

Source: Occupational Outlook Handbook, 1980-81

Many industrial technicians acquire experience that enables them to qualify for other jobs. For example, those specializing in machinery and production methods may move into industrial safety. Others, in job analysis, may set job standards and interview, test, hire, and train personnel. Still others may move into production supervision. (See statements on personnel workers and industrial engineers elsewhere in the *Handbook*.)

Mechanical Technology. Mechanical technology is a broad term that covers a large number of specialized fields including automotive, diesel, and production technology and tool and machine design.

Technicians assist engineers in design and development work by making freehand sketches and rough layouts of proposed machinery and other equipment and parts. This work requires knowledge of mechanical principles involving tolerance, stress, strain, friction, and vibration factors. Technicians also analyze the costs and practical value of designs.

In planning and testing experimental machines and equipment for performance, durability, and efficiency, technicians record data, make computations, plot graphs, analyze results, and write reports. They sometimes recommend design changes to improve performance. Their job often requires skill in the use of complex instruments, test equipment, and gauges, as well as in the preparation and interpretation of drawings.

When a product is ready for production, technicians help prepare layouts and drawings of the assembly process and of parts to be manufactured. They frequently help estimate labor costs, equipment life, and plant space. Some mechanical technicians test and inspect machines and equipment in manufacturing departments or work with engineers to eliminate production problems. Others are technical sales workers.

Tool designers are among the better known specialists in mechanical engineering technology. Tool designers prepare sketches of designs for cutting tools, jigs, dies, special fixtures, and other devices used in mass production. Frequently, they redesign existing tools to improve their efficiency. They also make, or supervise others who make detailed drawings of tools and fixtures.

Machine drafting with some designing, another major area often grouped under mechanical technology, is described in the statement on drafters. (Also see statements on mechanical engineers, automobile mechanics, and manufacturers' sales workers elsewhere in the *Handbook*.)

Instrumentation Technology. Automated manufacturing and industrial processes, oceanographic and space exploration, weather forecasting, satellite communication systems, environmental protection, and medical research have helped to make instrumentation technology a fast-growing field. Technicians help develop and design complex measuring and control devices such as those in a spacecraft that sense and measure changes in heat or pressure, automatically record data, and make necessary adjustments. These technicians have extensive knowledge of physical sciences as well as electrical-electronic and mechanical engineering.

Several areas of opportunity exist in the physical sciences: *Chemical technicians* work with chemists and chemical engineers to develop, sell, and utilize chemical and related products and equipment.

Most chemical technicians do research and development, testing, or other laboratory work. They often set up and conduct tests on processes and products being developed or improved. For example, a technician may examine steel for carbon, phosphorus, and sulfur content or test a lubricating oil by subjecting it to changing temperatures. The technician measures reactions, analyzes the results of experiments, and records data that will be the basis for decisions and future research.

Chemical technicians in production generally put into commerical operation those products or processes developed in research laboratories. They assist in making the final design, installing equipment, and training and supervising operators on the production line. Technicians in quality control test materials, production processes, and final products to insure that they meet the manufacturer's specifications and quality standards. Many also sell chemicals or chemical products as technical sales personnel.

Many chemical technicians use computers and instruments, such as a dilatometer (which measures the expansion of a substance.) Because the field of chemistry is so broad, chemical technicians frequently specialize in a particular industry, such as food processing or pharmaceuticals. (See statements on chemists, chemical engineers, and occupations in the industrial chemical industry elsewhere in the *Handbook*.)

Meteorological technicians support meteorologists in the study of atmospheric conditions. Technicians calibrate instruments, observe, record, and report meteorological occurrences, and assist in research projects and the development of scientific instruments.

Geological technicians assist geologists in evaluating earth processes. Currently much research is being conducted in seismology, petroleum and mineral exploration, and ecology. These technicians install and record measurements from seismographic instruments, assist in field evaluations of earthquake damage and surface displacement, or assist geologists in earthquake prediction research. In petroleum and mineral exploration, they help conduct tests and record sound wave data to determine the likelihood of successful drilling, or use radiation detection instruments and collect core samples to help geologists evaluate the economic possibilities of mining a given resource.

Hydrologic technicians gather data to help hydrologists predict river stages and water quality levels. They monitor instruments that measure water flow, water table levels, or water quality, and record and analyze the data obtained. (See statement on environmental scientists elsewhere in the *Handbook*.)

Technicians in the life sciences generally are classified in either of two broad categories:

Agricultural technicians work with agricultural scientists in food production and processing. Plant technicians conduct tests and experiments to improve the yield and quality of crops, or to increase resistance to disease, insects, or other hazards. Technicians in soil science analyze the chemical and physical properties of various soils to help determine the best uses for these soils. Animal husbandry technicians work mainly with the breeding and nutrition of animals. Other agricultural technicians are employed in the food industry as food processing technicians. In quality control or in food science research they help scientists develop better and more efficient ways of processing food material for human consumption. (See statement on food technologists elsewhere in the *Handbook*.)

Biological technicians work primarily in laboratories where they perform tests and experiments under controlled conditions. Microbiological technicians study microscopic organisms and may be involved in immunology or parasitology research. Laboratory animal technicians study and report on the reaction of laboratory animals to certain physical and chemical stimuli. They also study and conduct research to help biologists develop cures for human diseases. By conducting experiments and reporting the results to a biochemist, technicians assist in analyzing biological substances (blood, other body fluids, foods, and drugs). A biological technician also might work with insects to study insect control, develop new insecticides, or determine how to use insects to control other insects or undesirable plants. (See statements on life scientists elsewhere in the *Handbook*.)

Technicians also specialize in fields such as metallurgical (metal), electrical, and optical technology. In the atomic energy field, technicians work with scientists and engineers on problems of radiation safety, inspection, and decontamination. (See statement on occupations in the atomic energy field elswhere in the *Handbook*.) New areas of work include environmental protection, where technicians study the problems of air and water pollution, and industrial safety.

Working Conditions

Technicians work under a wide variety of conditions. Most work regular hours in laboratories and industrial plants. Others work part or all of their time outdoors. Some occasionally are exposed to safety or health hazards from equipment or materials.

Places of Employment

Over 600,000 persons worked as engineering and science technicians in 1978. About two-thirds of all technicians worked in private industry. In the manufacturing sector the largest employers were the electrical equipment, chemical, machinery, and aerospace industries. In nonmanufacturing, large numbers worked in wholesale and retail trade, communications, and in engineering and architectural firms.

In 1978, the Federal Government employed about 90,000 technicians, chiefly as engineering and electronics technicians, biological technicians, cartographic (mapmaking) technicians, meteorological technicians and physical science technicians. The largest number worked for the Department of Defense; most of the others worked for the Departments of Transportation, Agriculture, Interior, and Commerce.

State government agencies employed nearly 50,000 engineering and science technicians, and local governments about 11,500. The remainder worked for colleges and universities and nonprofit organizations.

Training, Other Qualifications, and Advancement

Although persons can qualify for technician jobs through many combinations of work experience and education, most employers prefer applicants who have had some specialized technical training. Specialized training is available at technical institutes, junior and community colleges, area vocational-technical schools, extension divisions of colleges and universities, and vocational-technical high schools. Some engineering and science students who have not completed the bachelor's degree and others who have degrees in science and mathematics also are able to qualify for technician positions.

Persons also can qualify for technician jobs by less formal methods. Workers may learn through on-the-job training, apprenticeship programs, or correspondence schools. Some qualify on the basis of experience gained in the Armed Forces. However, postsecondary training is becoming increasingly necessary for advancement to more responsible jobs.

Some of the types of postsecondary and other schools that provide technical training are discussed in the following paragraphs:

Technical Institutes. Technical institutes offer training to qualify students for a job immediately after graduation with a minimum of on-the-job training. In general, students receive intensive technical training but less theory and general education than in engineering schools or liberal arts colleges. A few technical institutes and community colleges offer cooperative programs in which students spend part of the time in school and part in paid employment related to their studies.

Some technical institutes operate as regular or extension divisions of colleges and universities. Other institutions are operated by States and municipalities, or by private organizations.

Junior and Community Colleges. Curriculums in junior and community colleges which prepare students for technician occupations are similar to those in technical institutes but emphasize theory and liberal arts. After completing the 2-year programs, some graduates qualify for technician jobs while others continue their education at 4-year colleges.

Area Vocational-Technical Schools. These postsecondary public institutions serve students from surrounding areas and emphasize training in skills needed by employers in the local area. Most require a high school degree or its equivalent for admission.

Other Training. Some large corporations conduct training programs and operate private schools to meet the needs of technically trained personnel in specific jobs; such training rarely includes general studies. Training for some technician occupations, for instance tool designers and electronic technicians, is available through formal 2- to 4-year apprenticeship programs. The apprentice gets on-the-job training under the close supervision of an experienced technician and related technical knowledge in classes, usually after working hours.

The Armed Forces have trained many technicians, especially in electronics. Although military job requirements generally differ from those in the civilian economy, military technicians often find employment with only minimal additional training.

Many private technical and correspondence schools often specialze in a single field of technical training such as electronics. Some of these schools are owned and operated by large corporations that have the resources to provide up-to-date training in a technical field.

Those interested in a career as a technician should have an aptitude for mathematics and science and enjoy technical work. An ability to do detailed work with a high degree of accuracy is necessary; for design work, creative talent also is desirable. Technicians are part of a scientific team, and often work closely with engineers and scientists as well as other technicians and skilled workers. Some technicans, such as repair and maintenance technicians, should be able to work independently and to deal effectively with customers.

Engineering and science technicians usually begin work as trainees in routine positions under the direct supervision of an experienced technician, scientist, or engineer. As they gain experience, they receive more responsibility and carry out a particular assignment under only general supervision. Technicians may eventually move into supervisory positions. Those who have the ability and obtain additional education occasionally may be promoted to positions as scientists or engineers.

Employment Outlook

Employment opportunities for engineering and science technicians are expected to be favorable through the 1980's. Opportunities will be best for graduates of postsecondary school technician training programs. Besides openings resulting from the slightly faster than average growth expected in this field, additional technicians will be needed to replace those who die, retire, or leave the occupation.

Industrial expansion and the increasing complexity of modern technology underlie the anticipated increase in demand for technicians. Many will be needed to work with the growing number of engineers and scientists in developing, producing, and distributing new and technically advanced products. Automation of industrial processes and continued growth of new areas of work such as environmental protection and energy development will add to the demand for technical personnel.

The anticipated growth of research and development expenditures in industry and government also should increase requirements for technicians.

Earnings

In private industry in 1977, technicians who completed a 2-year post-high school program earned starting salaries of about $10,500 a year, according to a survey by the Engineering Manpower Commission; those who did not complete a 2-year program started at about $9,000 a year. Graduates of 2-year programs with 5 years' experience earned about $12,800 a year in 1977, while nongraduates with some experience earned about $11,100. Senior technicians averaged about $18,700 a year in 1978, according to a Department of Labor survey.

Starting salaries for all technicians in the Federal Government were fairly uniform in 1979. A high school graduate with no experience could expect $8,366 annually to start. With an associate degree, the starting salary was $9,391, and with a bachelor's, $10,507 or $13,014. With more experience, however, earnings are significantly higher. The average annual salary for all engineering technicians employed by the Federal Government in 1978 was $19,617; for physical science technicians, $15,935; and for life science technicians, about $11,375.

Related Occupations

Engineering and science technicians apply scientific principles in their work. Other occupations whose work activities involve the application of scientific principles include foresters, forestry technicians, range managers, soil conservationists, engineers, environmental, life, and physical scientists, broadcast technicians, drafters, surveyors, television and radio service technicians, dental laboratory technicians, and medical technologists and technicians.

Sources of Additional Information

For information on careers in engineering and technology contact:

Engineers Council for Professional Development, 345 East 47th St., New York, N.Y. 10017.

Information on schools offering technician programs is available from:

National Association of Trade and Technical Schools, 2021 K St. N.W., Washington, D.C. 20006

State departments of education also have information about approved technical institutes, junior colleges, and other educational institutions within the State offering post-high school training for specific technical occupations. Other sources include:

American Association of Community and Junior Colleges, One Dupont Circle, Suite 410, Washington, D.C. 20036.

National Home Study Council, 1601 18th St. NW., Washington, D.C. 20009.

Appendix D

COPY OF SCHOOL SURVEY QUESTIONNAIRE

July 31, 1981

Dear Area Vocational-Technical School Directors,

We are seeking your cooperation in filling out the attached questionnaire. As a Vocational-Technical School Director you were chosen because of your first hand knowledge of the school's needs as well as experience within the school system.

The questionnaire is designed to obtain information regarding high technology programs in your school. When the results are tabulated we will begin reviewing curriculum to help schools become more responsive to industry's demand for qualified personnel.

Due to time constraints we would like for you to return the completed questionnaire to us by Sept. 30, 1981. Please return to:

Ms. Carol Aton
Georgia Institute of Technology
EES/TAL/TTB
Atlanta, GA 30332

Thank you for your time.

Sincerely,

Carol L. Aton, Chief
Technology Transfer Branch

sel

I. GENERAL DESCRIPTION OF TASK

This survey, conducted by the Georgia Institute of Technology through its Technology Applications Laboratory, is part of the research study project funded through the Office of Vocational Education that Mr. Robert K. Mabry discussed in his letter dated July 10, 1981. The purpose of this project is to determine present and future requirements for Postsecondary Vocational/Technical Schools to fill the needs of high technology industries in Georgia.

The key questions we are addressing include

1. Which high technology industries will flourish in Georgia over the next two decades and what demands will they have regarding skilled labor?
2. What changes, if any, will make the vocational/technical school system most responsive to these needs and what are the impacts of these changes?

We are interested in barriers to implementation and methods of delivery.

II. GENERAL DESCRIPTION OF HIGH TECHNOLOGY

Our definition of a high technology industry is one that needs trained personnel in the areas of microprocessors, computers, lasers, silicon chips, metallurgy, fiber optics, robotics, hydroponics, instrumentation, bio-chemistry, bio-engineering, genetics, energy, medicine, micro-miniaturization, vacuum processes, hydraulics, pneumatics, motor controls, mechanics, and automated production processes.

III. QUESTIONNAIRE

1. Do you perceive the following as problems in the implementation of high technology programs in your vocational/technical school? Please circle the appropriate answer.

A.	Teacher salaries you can pay	YES	NO
B.	Certification requirements	YES	NO
C.	Competition with industry for qualified personnel	YES	NO
D.	Space (facilities)	YES	NO
E.	Equipment	YES	NO
F.	Consumables	YES	NO
G.	Governance	YES	NO
H.	Quality of students	YES	NO
I.	Availability of jobs	YES	NO
J.	Leadership at State level	YES	NO
K.	Lack of interest by industry	YES	NO
L.	Money	YES	NO
M.	School admissions requirements	YES	NO
N.	Expertise of existing teachers	YES	NO
O.	Updating skills of existing teachers	YES	NO
P.	Image of vocational education	YES	NO
Q.	Recruitment of qualified students	YES	NO

R. Other (identify) ______________________________

____

2. Where do you think high technology programs should be offered for most effective results? Rank in order of preference where 1 indicates most preferred and 5 indicates least preferred.

   A. All schools. _______

   B. Only schools near an industrial region offering high technology employment. _______

   C. Specialty center within one existing school. _______

   D. An industrial facility or resource center outside the vocational system's existing brick and mortar structures. _______

   E. Other (identify) ______________________________ _______

3. How effective would the following methods of instruction be for high technology courses? Circle your answers according to the following code.

1	2	3	4	5
extremely effective	somewhat effective	effective	marginally effective	least effective

A. High technology courses delivered to all vocational/technical schools by a mobile classroom/lab.

1 2 3 4 5

B. High technology courses offered in one location then delivered by videotape to other vocational/technical schools.

1 2 3 4 5

C. High technology courses delivered in conjunction with on-the-job training at industrial sites.

1 2 3 4 5

D. High technology courses delivered by computer-aided instruction or simulation.

1 2 3 4 5

E. Others (identify and rank)

4. How effective would co-operative teaching ventures between traditional vo-tech instructors and the following personnel be for high technology courses? Circle your answer according to the code in Question 3.

A. Industry personnel

1 2 3 4 5

B. Training consultants

1 2 3 4 5

C. University faculty and staff

1 2 3 4 5

D. Others (identify and rank)

5. Is the content of the following programs offered in your school geared toward high technology employment? Circle your answer.

A. Data Processing	YES	NO	NOT OFFERED
B. Electronic Technology	YES	NO	NOT OFFERED
C. Electro-Mechanical	YES	NO	NOT OFFERED
D. Drafting/Design Technology	YES	NO	NOT OFFERED
E. Mechanical Technology	YES	NO	NOT OFFERED

F. Others (identify) ____________________

____

____

6. Where have you acquired your existing instructional materials for the programs you identified in Question 5 as geared toward high technology employment? Check the boxes that apply.

	Military	Consultants	Industry	Teachers	State Curricu-lum Center	Other
Data Processing						
Electronic Technology						
Electro Mechanical						
Drafting/Design Technology						
Mechanical Technology						
Others(identify)						

If you need more room please use the back of this page.

7. The feedback that you receive about your high technology courses comes from different sources. Have the following sources helped you evaluate your high technology programs? Circle your answer.

A. Students in program — YES NO

B. Placement of students in high technology companies — YES NO

C. Local advisory councils — YES NO

D. High technology personnel — YES NO

E. Others (identify) ____________________

8. Do you feel that your high technology programs are state-of-the-art? Circle your answer.

A. Data Processing	YES	NO	DON'T KNOW
B. Electronic Technology	YES	NO	DON'T KNOW
C. Electro-Mechanical	YES	NO	DON'T KNOW
D. Drafting/Design Technology	YES	NO	DON'T KNOW
E. Mechanical Technology	YES	NO	DON'T KNOW

F. Others (identify) ______________________

____

____

9. What changes are required to upgrade your programs to state-of-the-art in high technology? Check the changes that apply.

	Data Processing	Electronic	Electro-Mechanical	Drafting Design	Mechanical
Develop new curriculum					
Hire qualified teachers					
Obtain additional funding					
Update skills					
Add courses					
Eliminate courses					
Update equipment					
Others (identify)					

If you need more room please use the back of this page.

10. We are interested in additional comments you may have regarding high technology programs in vocation/technical schools.

NAME ______________________________

ADDRESS ______________________________

____

SCHOOL NAME: ______________________________

GOVERNED BY: ______________________________

Please return by Sept. 30, 1981. Your prompt response will be much appreciated.

RETURN TO: Ms. Carol Aton
Georgia Tech
EES-TAL
O'Keefe Rm 209
Atlanta, GA 30332

Appendix E

PLACEMENT DATA FOR
SELECTED HIGH TECHNOLOGY TRAINING

Table E-1

PLACEMENT OF VOCATIONAL-TECHNICAL SCHOOL GRADUATES
IN COMPUTER-RELATED PROGRAMS, 1981

School	Available for Employment	Positive Placements*	Placement Rate %
Albany	20	18	90
Athens	31	28	90
Atlanta	9	8	89
Augusta	22	22	100
Bainbridge Jr. College	0	0	-
Ben Hill-Irwin	--	-	-
Brunswick Jr. College	27	16	59
Carroll	10	9	90
Columbus	33	24	73
Coosa Valley	25	21	84
Dalton Jr. College	8	8	100
DeKalb	73	67	92
Griffin-Spalding	29	28	97
Houston Voc. Ctr.	--	-	--
Lanier	28	24	86
Macon	23	21	91
Marietta-Cobb	65	63	97
Moultrie	--	-	--
North Georgia	23	17	74
Pickens	11	10	91
Savannah	10	9	90
South Georgia	13	9	69
Swainsboro	--	-	--
Thomas	29	27	93
Troup	--	-	--
Upson	--	-	--
Valdosta	22	18	82
Walker	20	12	60
Waycross-Ware	10	9	90
TOTALS	541	468	86

*Students who found a job in the specific or a related field within 3 months of completion of training, continued education, or entered military.

Source: Student (Product) Evaluation, Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring 1981: Georgia Vocational Management Information System, September 1981.

Table E-2

PLACEMENT OF VOCATIONAL-TECHNICAL SCHOOL GRADUATES
IN ELECTRONIC TECHNOLOGY 1981

School	Available for Employment	Positive Placements*	Placement Rate %
Albany	7	7	100
Athens	35	31	89
Atlanta	20	16	80
Augusta	32	32	100
Bainbridge Jr. College	--	-	---
Ben Hill-Irwin	--	-	---
Brunswick Jr. College	--	-	---
Carroll	--	-	---
Columbus	43	42	98
Coosa Valley	12	11	92
Dalton Jr. College	2	2	100
DeKalb	25	25	100
Griffin-Spalding	12	12	100
Houston Voc. Ctr.	19	19	100
Lanier	12	12	100
Macon	20	16	91
Marietta-Cobb	37	36	97
Moultrie	15	15-	100
North Georgia	18	15	83
Pickens	7	4	57
Savannah	6	6	100
South Georgia	19	17	89
Swainsboro	8	8	100
Thomas	12	12	100
Troup	2	2	100
Upson	8	8	100
Valdosta	8	8	100
Walker	16	12	75
Waycross-Ware	8	7	88
TOTALS	403	375	93

*Students who found a job in the specific or a related field within 3 months of completion of training, continued education, or entered military.

SOURCE: Student (Product), Evaluation-Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring 1981: Georgia Vocational Management Information System, September 1981.

Table E-3

PLACEMENT OF VOCATIONAL-TECHNICAL SCHOOL GRADUATES
IN ELECTROMECHANICAL TECHNOLOGY, 1981

School	Available for Employment	Positive Placements*	Placement Rate %
Albany	--	-	---
Athens	33	30	91
Atlanta	--	-	---
Augusta	--	-	---
Bainbridge Jr. College	--	-	---
Ben Hill-Irwin	13	13	100
Brunswick Jr. College	--	-	---
Carroll	--	-	---
Columbus	--	-	---
Coosa Valley	--	-	---
Dalton Jr. College	--	-	---
DeKalb	17	17	100
Griffin-Spalding	--	-	---
Houston Voc. Ctr.	--	-	---
Lanier	--	-	---
Macon	--	-	---
Marietta-Cobb	10	10	100
Moultrie	--	-	---
North Georgia	--	-	---
Pickens	--	-	---
Savannah	--	-	---
South Georgia	--	-	---
Swainsboro	--	-	---
Thomas	0	0	---
Troup	0	0	---
Upson	--	-	---
Valdosta	--	-	---
Walker	--	-	---
Waycross-Ware	--	-	---
TOTALS	73	70	96

*Students who found a job in the specific or a related field within 3 months of completion of training, continued education, or entered military.

Source: Student (Product) Evaluation, Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring 1981: Georgia Vocational Management Information System, September 1981.

Table E-4

PLACEMENT OF VOCATIONAL-TECHNICAL SCHOOL GRADUATES
IN DRAFTING OCCUPATIONS, 1981

School	Available for Employment	Positive Placements*	Placement Rate %
Albany	0	0	---
Athens	8	7	88
Atlanta	23	22	96
Augusta	-	-	---
Bainbridge Jr. College	-	-	---
Ben Hill-Irwin	9	8	89
Brunswick Jr. College	-	-	---
Carroll	12	11	92
Columbus	0	0	---
Coosa Valley	-	-	---
Dalton Jr. College	17	6	35
DeKalb	43	39	91
Griffin-Spalding	11	10	91
Houston Voc. Ctr.	20	20	100
Lanier	-	-	---
Macon	-	-	---
Marietta-Cobb	20	19	95
Moultrie	-	-	---
North Georgia	-	-	---
Pickens	-	-	---
Savannah	-	-	---
South Georgia	24	15	63
Swainsboro	11	11	100
Thomas	-	-	---
Troup	12	9	75
Upson	14	13	93
Valdosta	-	-	---
Walker	-	-	---
Waycross-Ware	10	10	100
TOTALS	234	200	85

*Students who found a job in the specific or a related field within 3 months of completion of training, continued education, or entered military.

SOURCE: Student (Product) Evaluation, Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring 1981: Georgia Vocational Management Information System, September 1981.

Table E-5

PLACEMENT OF VOCATIONAL-TECHNICAL SCHOOL GRADUATES
IN MECHANICAL TECHNOLOGY, 1981

School	Available for Employment	Positive Placements*	Placement Rate %
Albany	11	11	100
Athens	12	12	100
Atlanta	--	-	---
Augusta	16	16	100
Bainbridge Jr. College	--	-	---
Ben Hill-Irwin	--	-	---
Brunswick Jr. College	2	2	100
Carroll	--	-	---
Columbus	16	13	81
Coosa Valley	16	14	88
Dalton Jr. College	--	-	---
DeKalb	17	17	100
Griffin-Spalding	--	-	---
Houston Voc. Ctr.	--	-	---
Lanier	--	-	---
Macon	21	19	90
Marietta-Cobb	--	-	---
Moultrie	8	8-	100
North Georgia	25	23	92
Pickens	11	9	82
Savannah	6	6	100
South Georgia	--	-	---
Swainsboro	--	-	---
Thomas	13	13	100
Troup	--	-	---
Upson	--	-	---
Valdosta	--	-	---
Walker	17	15	88
Waycross-Ware	--	-	---
TOTALS	191	178	93

*Students who found a job in the specific or a related field within 3 months of completion of training, continued education, or entered military.

SOURCE: Student (Product) Evaluation, Analysis for Individual Schools, Post-Secondary Area Vocational-Technical Schools for June/Spring 1981: Georgia Vocational Management Information System, September 1981.

Appendix F

LIST OF CONTACTS FOR EIGHT OTHER STATES

CONTACTS FOR OTHER STATES

Arkansas	Richard Cochran, Deputy Director Industry Training Program State Department of Education
California	Gerald D. Cresci, Special Assistant to the Chancellor for Occupation Education California Community Colleges
Florida	Patsy Agee, Bureau Chief Bureau of Vocational Programs and Staff Development Thomas Rushing, Director of Industrial Education Bureau of Vocational Programs and Staff Development Florida Division of Education
Massachusetts	John DiRienzo, Coordination of Industry and Education State Department of Education
North Carolina	Larry Blake, President Department of Community Colleges
Oregon	Monty Multanen, Director of Vocational Education State Department of Education
South Carolina	Jack Powers, Director Office of Innovative Training State Board of Comprehensive and Technical Education
Texas	William A. Grusy, Director Division of Post-Secondary Vocational Programs Department of Occupational Education and Technology State Board of Education

Appendix G

LIST OF RECOMMENDED EQUIPMENT

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

December 4, 1981

Mr. Robert K. Mabry, Coordinator
Department of Education
Office of Vocational Education
State Office Building, Room 333
Atlanta, GA 30334

Dear Bob:

Attached is the information regarding equipment for high technology programs per your request. Included are basic level and pilot level equipment requirements as well as a list of suggested equipment vendors. Please note the following:

1. These lists represent <u>minimum</u> requirements.

2. These lists are cumulative within each respective technology. That is, B-level programs require equipment from A <u>and</u> B; C-level programs require equipment from A, B, <u>and</u> C.

3. Sharing of high-dollar items between programs within a single school is recommended. Items that qualify are bracketed.

4. This list was drawn up with input from high technology industries and from the schools. However, because the three areas are generic and because industry needs will change over the next few years, the Georgia Tech team recommends that this list be used as a guideline only.

I have also enclosed individual school "wish" lists for your use.

Sincerely,

Carol L. Aton, Chief
Technology Transfer Branch
EES-TAL
(404) 894-3412

sel

Enclosures

BASIC LEVEL TEACHING EQUIPMENT

VO-TECH SCHOOLS

	Page	Totals
Electronics Technology		
Segment A - Electronics Fundamentals & Passive Components	1	$ 26,700
B - Basic Circuits & Active Devices	2	15,430
C - Integrated Circuits, Digital and Microprocessor Fundamentals, A/D & D/A Conversion Techniques	3	57,320
		$ 99,450
Electro-Mechanical Technology		
Segment A - Mathematics, Science & Drafting Fundamentals	4	$104,000
B - Basic Electricity, Electronics & Computer Programming	5	52,600
C - Motor Controls, Metal Working & Industrial Electronics Applications	6	308,300
		$464,900
Mechanical Technology		
Segment A - Mathematics, Science & Drafting Fundamentals	7	$104,000
B - Computer Programming & Basic Electricity	8	39,800
C - Metal Working and Fluid Controls	9	245,000
		$388,800

Note: This is a suggested equipment list which is considered to be a minimum requirement to carry out basic level programs.

ELECTRONICS TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment A - Electronics Fundamentals & Passive Components

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Basic Electronics Trainer and Accessories	10	$325	$3,250
Combination Hi/Lo DC/AC Power Supply		10	445	4,450
Function Generator		10	200	2,000
VOM		10	150	1,500
Digital Multimeter		10	650	6,500
Student Quality Oscilloscope		10	700	7,000
Resistance Decade		5	100	500
Capacitor Sub. Box		5	50	250
Isolation Transformer		10	125	1,250
				$26,700

ELECTRONICS TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment B - Basic Circuits & Active Devices

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Electronics Circuit Trainer and Accessories	7	$220	$1,540
Tri-Low-Voltage Power Supply		7	200	1,400
Signal Generator		7	500	3,500
Curve Tracer		1	7,700	7,700
Transistor Tester		1	240	240
Tube Tester		1	550	550
RCL (Impedance) Bridge		1	500	500
				$15,430

ELECTRONICS TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment C - Integrated Circuits, Digital and Microprocessor Fundamentals, A/D & D/A Conv. Tech.

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Integrated Circuit Trainer and Accessories	10	$ 400	$ 4,000
	Digital Techniques Trainer and Accessories	10	255	2,550
	Microprocessor Trainer and Accessories	10	425	4,250
Test Lab Quality Dual-Trace Oscilloscope with Delayed Sweep and Storage		1	6,860	6,860
Industrial Quality Dual-Trace Oscilloscope		10	2,000	20,000
Scope Probes		20	60	1,200
Data Analyzer, with options		1	4,000	4,000
Logic Probe (TTL, CMOS)		3	125	375
Logic Probe (ECL)		1	200	200
Logic Pulser		2	195	390
Logic Clip		3	165	495
Current Tracer		1	375	375
Logic Comparator with Ref. Brd.		1	625	625
	D/A & A/D Devices	1	4,000	4,000
	Transducer Systems	1	4,000	4,000
	Miscellaneous Interfacing Devices and Components	1	4,000	4,000
				$57,320

ELECTRO-MECHANICAL TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment A - Mathematics, Science & Drafting Fundamentals

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Drafting Tables	20	$ 500	$10,000
	Tracking Drafters	20	350	7,000
These items to be used jointly with mechanical and electromechanical technology	Diazo Printer	1	1,500	1,500
	Hardening Furnace	1	10,000	10,000
	Tempering Furnace	1	9,000	9,000
	Polishing Table	2	2,000	4,000
	Grinding Table	2	2,000	4,000
	Cut-off Machine	1	6,000	6,000
	Mold Press	3	1,500	4,500
	Belt Surfacer	2	3,000	6,000
	Metallurgical Microscope	4	3,000	12,000
	Metallograph	1	30,000	30,000
				$104,000

ELECTRO-MECHANICAL TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment B - Basic Electricity, Electronics & Computer Programming

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Digital Multi-Meters		30	$ 200	$ 6,000
Oscilloscopes		20	420	8,400
Power Supply		2	300	600
Signal Generator		2	300	600
	Digital Trainer	20	160	3,200
Sharing Possible with	Mini-computer	10	2,000	20,000
Mechanical Program	Computer Printer	10	900	9,000
	Electronic Experimental Trainer/Parts	30	160	4,800
				$52,600

ELECTRO-MECHANICAL TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment C - Motor Controls & Metal Working, Industrial Electronics Applications

Equipment/ Instrumentation		Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Surface Grinders			3	$10,000	$30,000
Lathes, 15"	Sharing		3	20,000	60,000
Vertical Mills	Possible		3	8,000	24,000
Horizontal Mills	with		3	30,000	90,000
Tool Sets and Gages	Mechanical		12	500	6,000
Electric Motors	Program		10	70	700
Compressor Motors			4	150	600
		Hydraulic Trainers with Accessories	2	7,500	15,000
		Pneumatic Trainers	2	5,000	10,000
		Electromechanical Control Systems	10	1,000	10,000
		D/A and A/D Devices	1 set	4,000	4,000
		Transducer Systems	1 set	4,000	4,000
		Miscellaneous Interfacing Devices and Components	1 set	4,000	4,000
		Industrial Motor Control	2	2,500	5,000
		Industrial Measurement & Controls	2	1,250	2,500
		Numerical Control (N/C) Training System	1	25,000	25,000
		Programmable Controllers	2	5,000	10,000
Instrumentation (Torque Meas.; Speed Meas.; Position Meas.; Pressure Meas.; Flow Meas.; Temp. Meas.; etc.)			1 set	7,500	7,500
					$308,300

MECHANICAL TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment A - Mathematics, Science & Drafting Fundamentals

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Drafting Tables	20	$ 500	$10,000
	Track Drafters	20	350	7,000
These items to be used jointly with mechanical and electro-mechanical technology	Diazo Printer	1	1,500	1,500
	Hardening Furnace	1	10,000	10,000
	Tempering Furnace	1	9,000	9,000
	Polishing Table	2	2,000	4,000
	Grinding Table	2	2,000	4,000
	Cut-off Machine	1	6,000	6,000
	Mold Press	3	1,500	4,500
	Belt Surfacer	2	3,000	6,000
	Metallurgical Microscope	4	3,000	12,000
	Metallograph	1	30,000	30,000
				$104,000

MECHANICAL TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment B - Computer Programming & Basic Electricity

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Sharing possible with Electro-Mechanical Program	Mini-Computer with Disks	10	$2,000	$20,000
	Computer Printer	10	900	9,000
	Electronic Experimental Trainer/Parts	30	160	4,800
Digital Multi-Meters		30	200	6,000
				$39,800

MECHANICAL TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Segment of Program - Segment C - Metal Working & Fluid Controls

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Surface Grinder (Sharing Possible with Electro-Mechanical Program)		3	$10,000	$30,000
Lathes, 15" (Sharing Possible with Electro-Mechanical Program)		3	20,000	60,000
Vertical Mill (Sharing Possible with Electro-Mechanical Program)		3	8,000	24,000
Horizontal Mill (Sharing Possible with Electro-Mechanical Program)		3	30,000	90,000
Tool Sets and Gages		12	500	6,000
	Hydraulic Trainers with Accessories	2	7,500	15,000
	Pneumatic Trainers	2	5,000	10,000
	Motor Control Trainers	10	1,000	10,000
				$245,000

PILOT LEVEL TEACHING EQUIPMENT

VO-TECH SCHOOLS

	Page	Totals
Electronics Engineering Technology	1	$260,360
Electro-Mechanical Engineering Technology	2	243,000
Mechanical Engineering Technology	3	370,000
		$873,360

Note: This is a suggested equipment list which is considered to be a minimum requirement to carry out pilot level programs.

Segment of Program- Pilot Level

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Spectrum Analyzer		1	$27,500	$27,500
Earth Satellite Receiving System		1	10,000	10,000
	Fiber Optics Training Units	5	4,000	20,000
Communications Systems (Feedback)		5	6,000	30,000
	Syncrho-Servo Training System	5	5,000	25,000
Oscilloscope with Options - High Resolution		6	7,685	46,110
Oscilloscope with Options - High Resolution/High Stability		2	12,225	24,450
Logic Analyzer with Options		1	6,700	6,700
Logic Analyzer with Options - High Resolution		1	10,600	10,600
System Controller with Options		1	7,000	7,000
Digital Counters		5	1,600	8,000
Digital Multimeter - Programmable		1	1,995	1,995
Universal Digital Counter/Timer - Programmable		1	3,875	3,875
Power Supply - Programmable		1	2,500	2,500
Oscilloscope - Dual Trace Storage		1	11,900	11,900
Read Only Memory (ROM) Programming System		1	25,000	25,000
				$260,630

ELECTRO-MECHANICAL ENGINEERING TECHNOLOGY

Segment of Program - Pilot Level

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Computer Assisted Drafting System		1	$97,000	$97,000
General Purpose Industrial Grade Robot - with 6 axis servo motion		1	85,000	85,000
	Basic Robot Trainer	1	24,000	24,000
	Console Micro Processor Development System to be used with Robot Trainer	1	30,000	30,000
Ultrasonic Flaw Detector		1	7,000	7,000
				$243,000

MECHANICAL ENGINEERING TECHNOLOGY

Segment of Program – Pilot Level

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
CNC Coordinate Measuring Machine		1	$ 75,000	$ 75,000
CNC Machine Turning Center		1	100,000	100,000
CNC Wire Feed EDM		1	75,000	75,000
CNC Floppy Disk Programming Center		1	20,000	20,000
Atmospheric Controlled Heat Treatment Center		1	25,000	25,000
Hardness Tester		1	10,000	10,000
Tensile Testing Machine		1	15,000	15,000
Digital Optical Comparator		1	30,000	30,000
Electronic Microscope		1	20,000	20,000
				$370,000

EQUIPMENT VENDORS

ELECTRONICS TECHNOLOGY

1. Tektronix
2. Scientific Atlanta
3. Heath
4. ECI
5. Simpson
6. Hewlett-Packard
7. B&K
8. General Radio
9. Ternirit

ELECTRO-MECHANICAL TECHNOLOGY

1. Cincinnati-Millicron
2. ECI
3. Hickok
4. Allen Bradley
5. Radio Shack
6. Technical Systems
7. LeBlonde
8. Bridgeport
9. Brown & Sharp
10. Wagner
11. Vega
12. Cincinnati

MECHANICAL TECHNOLOGY

1. Bruning
2. Ozalid
3. Lindberg
4. Buehler
5. Leitz
6. Radio Shack
7. Heath
8. B&K
9. Hairy
10. LeBlonde
11. Bridgeport
12. Cincinnati
13. Brown & Sharp
14. Vega

Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of the Educational Amendments of 1972 and Title II of the Vocational Educational Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.

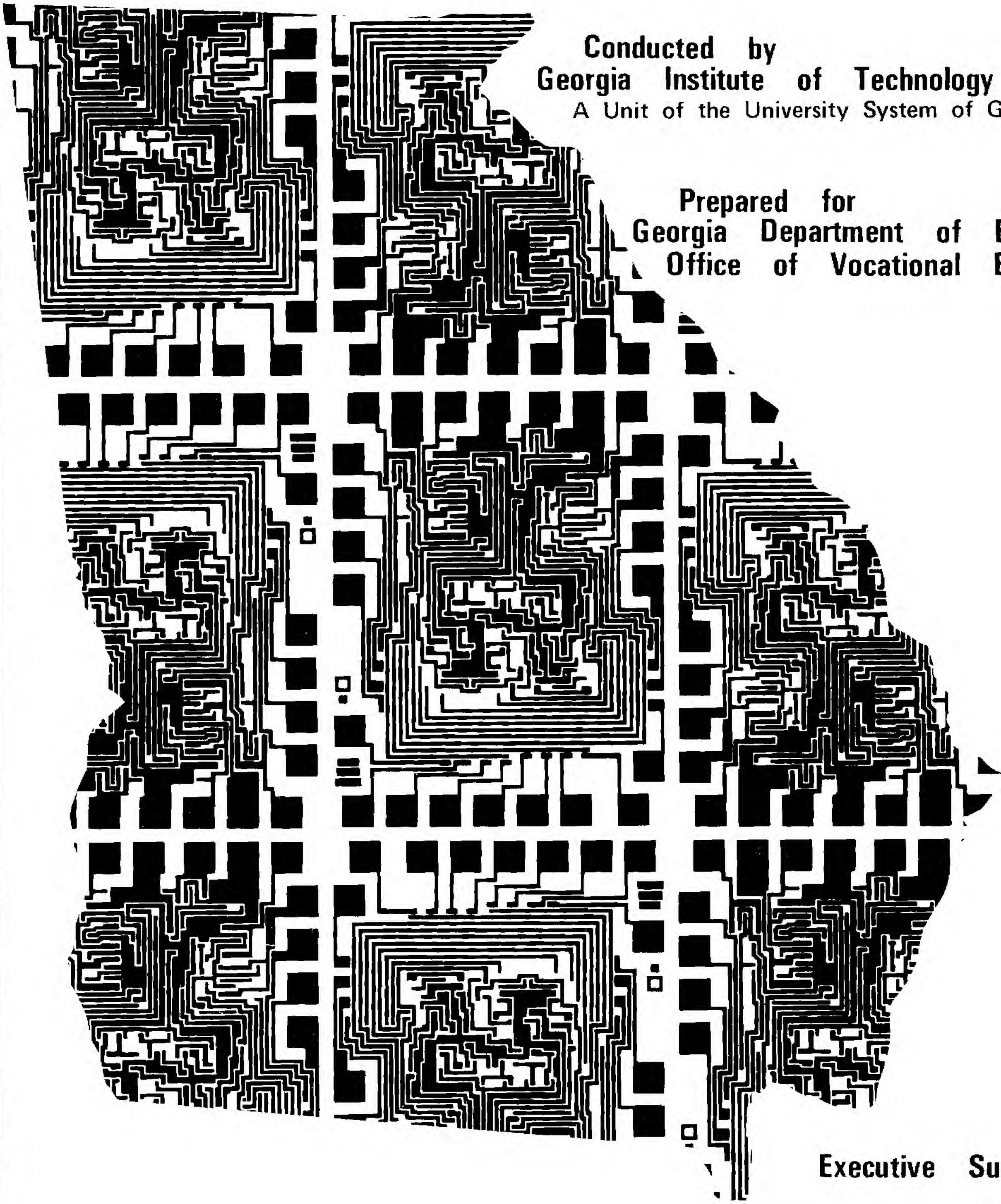
Employees, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.

The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy.

Title II	- Loydia Webber, Vocational Equity Coordinator
Title VI	- Peyton Williams, Jr., Associate Superintendent of State Schools and Special Services
Title IX	- Evelyn Rowe and Myra Tolbert, Coordinators
Section 504	- Jane Lee, Coordinator of Special Education

Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, State Office Building, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.

AN ADVANCED TECHNOLOGY STUDY FOR POST-SECONDARY AREA VOCATIONAL-TECHNICAL SCHOOLS



Conducted by
Georgia Institute of Technology
A Unit of the University System of Georgia

Prepared for
Georgia Department of Education
Office of Vocational Education

Executive Summary

Project A-2995

AN ADVANCED TECHNOLOGY STUDY
FOR POST-SECONDARY AREA VOCATIONAL-TECHNICAL SCHOOLS

Executive Summary

Submitted to

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Prepared by

C.L. Aton, Project Director
H.W. Hodges
F.A. Tarpley
V.A. Thomas
J.C. Wyvill

GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia 30332
A Unit of the University System of Georgia

September 1982

DISCLAIMER

This publication was prepared pursuant to an agreement with the State Board of Education of the State of Georgia. Contractors undertaking such projects under government sponsorship are encouraged to freely express their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent the official policy of The Board of Education of the State of Georgia or the U.S. Department of Education.

TABLE OF CONTENTS

	Page
Acknowledgments	iv
Preface	v
A. INTRODUCTION	1
B. FINDINGS	2
1. High Technology Trends	2
2. Industry's Perspective	4
3. School Systems' Perspective	11
4. Barriers	16
C. NEEDS	17
1. Programs	17
2. Delivery Systems	18
3. Equipment	18
4. Staff	20
D. RECOMMENDATIONS	22
1. System Needs	22
2. Program Needs	23
3. Staff Needs	25

ACKNOWLEDGMENTS

The authors wish to acknowledge the timely cooperation and enthusiasm of the area school directors and teachers as well as the knowledgeable assistance of staff in the Office of Vocational Education. Industry training personnel and training leaders in Georgia and in other states are also acknowledged for the insights and information provided. A note of appreciation goes to those who assisted us in preparing the Interim Report--R.D. Atkins, J. Banks, D. Betten, G.E. Kearney, R.G. Schwartz, and J.L. Walsh--for laying the foundation upon which this Final Report is based, and to T.F. McGowan and L.T. Rockett for their assistance in preparing a recommended list of training equipment.

A special thanks goes to Robert K. Mabry, our Technical Coordinator, for his professional support of our efforts.

PREFACE

The Office of Vocational Education at the Georgia Department of Education had the foresight to see that the state's post-secondary vocational-technical schools might not be able to keep pace with the advancements in technology. And this lag would occur at an inopportune time, because the Governor of Georgia was actively pursuing plans to attract high technology industry to the state, including the establishment of the Advanced Technology Development Center (ATDC) on the Georgia Tech campus. One of the foremost needs of the high technology industrial sector is a readily available skilled work force, a factor that could ultimately determine the viability of Georgia as a site for new high technology industry.

Consequently, the Office of Vocational Education contracted with the Georgia Institute of Technology in June 1981 to define directions and strategies for meeting training needs and providing a competitive edge in attracting this fast-paced, high growth industry to our state. At the same time, the Governor requested a background paper he could use in setting priorities for budget planning in the fall of 1981. This accelerated need for information culminated in an Interim Report, published in October 1981.

In that Interim Report, recommendations were made in four areas for the near term and two areas for the long term. It was recommended that electronics equipment be upgraded and that an equipment sharing program be developed. It was recommended that teacher salaries be increased, that more updating opportunities be provided, and that industry personnel be used as guest instructors. Other near term recommendations were to establish a model school on the cutting edge of technology and appoint a steering committee to define and direct vo-tech responses to high technology needs. The two long term recommendations were to implement programs in fiber/laser optics and biology as well as implement a two-year associate degree program within the vo-tech system including joint curricula with the junior colleges.

Governor Busbee and the Office of Vocational Education took immediate action in three of the near term areas and one of the long term areas:

- o An $8 million budget was established to upgrade equipment.
- o Three pilot schools were chosen in which to accelerate implementation of high technology programs.
- o A High Technology Advisory Council was appointed and a position for High Technology Coordinator was established.
- o A curriculum based on Accreditation Board for Engineering Technology (ABET) criteria was proposed for a two-year degree program.

Thus, even as this project was being completed, major steps were being taken to move the post-secondary vocational-technical school system out of a reactive response mode into an active leadership role in the area of high technology training.

A. INTRODUCTION

Economic development during the 1980's is predicted to center on high technology industries. National projections for high technology growth predict 7.1 million jobs and a $402 billion increase in sales over the next two decades.

In order for Georgia to develop its share of what is undoubtedly the fastest growing sector of the economy, efforts must be made to identify and fulfill the needs of high technology industries. An extremely important factor in attracting the interest of high technology firms is a visible commitment by government (as evidenced by the ability and willingness of a state to provide skilled technicians).

Well-trained, specialized workers are necessary both for the manufacture and use of most high technology products. The availability and quality of high technology educational programs is crucial to attracting new industry and encouraging the expansion of existing firms.

Industry need for highly trained technicians is so great that in many states, including Georgia, companies are hiring high technology students before they finish their programs. Intense competition among firms for the limited number of technicians presently available has led to high salary offers. In turn, career opportunities in high technology are attracting ever greater numbers of students, many of whom are experienced in the work place, and quick to recognize the potential advantages of high technology training provided by the vocational-technical school system.

The purpose of this study was to determine the level and extent of post-secondary vocational-technical training in advanced technologies necessary to meet current and projected industry needs.

The objectives of this study were to:

- Identify trends in societal and industrial change, as well as in associated technologies, and describe the resultant implications for training technicians in Georgia's post-secondary vocational-technical schools for the next 10 years and the next 20 years.
- Identify competencies for those technologies determined to be significant for training technicians to serve the needs of existing, expanding, and new industries in Georgia.
- Examine existing technology programs in area vocational-technical schools and determine the difference between those significant technologies which are taught and those which should be taught.
- Define new curriculum areas which are needed (or will be needed) and any necessary modifications in existing technical programs.
- Define and recommend the best delivery systems for high technology programs.

- Identify barriers to implementing recommendations.
- Define changes which should be made to overcome identified barriers.
- Recommend relatively inexpensive measures which should be implemented within 3 years; measures of intermediate cost which should be implemented within 3 to 10 years; and measures requiring extensive change and substantial costs which should be implemented over 10 to 20 years.

The results of this study show that the vo-tech system in Georgia must move quickly to provide for the evolving and growing needs of innovative quick-paced industry. Graduates from the vo-tech system must be taught the new skills required to meet current industry's needs and attract additional high technology companies to Georgia. It may take two years to prepare a curriculum and two more years to train workers; consequently, curriculum planners must be aware of industry needs at least four years in advance. Yet the rapid innovation taking place in high technology today can drastically change specific job skills over a four-year period. Therefore, early definition of a long range but flexible approach is necessary.

During the course of this project, information was gathered and analyzed to identify needs throughout the vo-tech school system and determine how best to meet those needs. In this executive summary, the findings on high technology trends in industry, the skills required by current and emerging high technology industry, and the barriers hindering the meeting of those requirements are summarized. Specific details on the needs of the vo-tech school system are then presented in the areas of programs, delivery systems, equipment, and staff. Finally, recommendations for the effective implementation of a well-directed statewide high technology program are presented, addressing system needs, program needs, and staff needs.

Overall system needs include continual strategic intelligence on industrial trends, a study of Georgia's system of governance, and increased industry involvement. Program needs include a rapid response mechanism to industry employment opportunities, a formal arrangement between the State Board of Education and the Board of Regents to cover the granting of two-year degrees, innovative training approaches, a major retraining plan, and procedures to deal with equipment shortages in the future. Staff needs include a training center, higher teacher salaries and incentives, and increased updating opportunities. More detailed descriptions of the findings, needs, and recommendations of this study are presented below.

B. FINDINGS

1. High Technology Trends

The State of Georgia must compete with other states both nationally and regionally for high technology industries and jobs. Much of Georgia's existing industrial employment is concentrated in traditional industries, such as textiles, apparel, and food processing. These traditional industries are mature in terms of both technology and market growth, and they are also subject to intense international competition. Georgia's best hope for economic progress lies in a dual strategy. The first aspect of this strategy is maintaining the viability of existing industries by incorporating new technological advances in such areas as automation and process control. Second, Georgia needs to attract and develop jobs in industries and technologies that will grow in the 1980's and beyond.

Estimating the direction and extent of the need for technicians with various types of skills during the rest of this century is a complex task for a number of reasons, but two are especially noteworthy.

First, the skills that will be needed are dependent on the technologies that emerge. Rapid innovation, a hallmark of high technology industries, can completely alter the type of technical support skills an industry requires. In the early days of solid state devices, persons with doctorates in chemical engineering grew the needed germanium crystals. Today the process is automated, and a person with minimal training can supervise several machines.

Second, the economic profile of Georgia will undoubtedly change. If Georgia is successful in attracting technology-based industries and modernizing existing industries, the need for technically trained workers will significantly increase. On the other hand, if Georgia's traditional industries fail to incorporate advances in process control and automation, and Georgia fails to attract and develop technology-based businesses, the number of skilled jobs will reflect this lack of progress.

Difficulties encountered in estimating the need for various types of technicians should not serve as a deterrent. Indeed, Georgia should continuously monitor its need for technicians in the light of its economic development goals and an ever-improving understanding of technological trends. In addition, this monitoring should be integrated with the planning process for vocational education within the state.

The traditional approach to projecting employment relies exclusively on previous employment patterns. However, this approach produces its best results when relationships remain stable, an invalid assumption for high technology. The method used in this study relies on more current industry trends and sales projections obtained from an extensive literature review and contacts with knowledgeable industry experts to adjust Georgia's 2% share of employment up or down.

Based on these industrial trends in the U.S. and Georgia, seven specific areas of high technology were chosen as having the greatest potential for growth in Georgia. These technology areas are: Computer Services, Computer Manufacturing, Communications, Avionics, Laser Technology, Biotechnology, and Solar Energy.

Employment projections for these areas are summarized in Table 1. Three time periods have been utilized: 1980-1985, 1985-1990, and 1990-2000. Except for Computer Services, these areas relate directly to the manufacture of high technology products. However, vocational-technical schools may experience more direct impacts from users of high technology applications. Existing U.S. manufacturers are using more and more sophisticated machines and processes as they strive to increase productivity and to remain competitive in the international marketplace. The applications of these technologies will influence the operations of a number of traditional industries.

The extent of the use of technology applications in the manufacturing process is very difficult to quantify. However, all authorities agree that the effect of automation will be extensive during the next 20 years. According to a recent study by Carnegie-Mellon University, almost 7 million manufacturing employees will be affected by automation during this period. Existing and anticipated advances in electronic industrial systems and manufacturing techniques will affect almost 13% of the work force by the year 2000. If the impact these advances will have on the office work force is included, almost 45%, or 45 million jobs, will be affected during the same period.

The impact of the microprocessor and other new manufacturing innovations will be generally felt throughout Georgia's traditional and emerging industries. Georgia's share of robot technicians alone will be 60 by 1985 and as many as 400 by 1990. New technological improvements in robotics, machining, electronics, and lasers will substantially change the face of American industry over the next 20 years; and Georgia's existing and future industries will be a part of this renovation.

To summarize, high technology industrial areas most likely to have a major impact on Georgia's economic development with implications for the training of technicians are:

NEAR TERM	MID TERM	LONG TERM
Computer Services Computer Manufacturing Communications Avionics	Laser Technology	Unknown

In addition, the effects of industrial automation should be monitored very closely in the near term for retraining opportunities within existing industries. Biotechnology and solar energy are not projected to have major impact; however, advances in these areas could change the employment outlook and should be monitored on a regular basis.

2. Industry's Perspective

Georgia Tech surveyed firms representing a broad spectrum of the high technology industrial sector, both producers and users, in order to assess

TABLE 1

ANTICIPATED EMPLOYMENT INCREASES

	INDUSTRY	SALES INCREASE ($ BILLIONS)	NEW NATIONAL EMPLOYMENT	NEW GEORGIA EMPLOYMENT	ANNUALIZED NEW GEORGIA EMPLOYMENT
1980-1985	Computer Services	NA	461,000	14,500	2,900
	Computer Manufacturing	$ 30.0	431,000	6,500	1,290
	Communications	$ 17.6	258,000	7,700	1,530
	Avionics	$ 5.9	110,000	3,300	660
	Laser Technology	$ 2.6	30,000	600	120
	Biotechnology	$ 2.8	32,000	300	60
	Solar Energy	$ 0.3	3,000	-----	-----
		$ 59.2	1,325,000	32,900	6,560
1985-1990	Computer Services	NA	461,000	14,500	2,900
	Computer Manufacturing	$ 35.0	486,000	7,200	1,440
	Communications	$ 32.4	476,000	14,300	2,860
	Avionics	$ 7.9	147,000	4,400	880
	Laser Technology	$ 5.3	61,000	1,200	240
	Biotechnology	$ 5.6	65,000	600	130
	Solar Energy	$ 0.6	7,000	70	10
		$ 86.8	1,703,000	42,270	8,460
1990-2000	Computer Services	NA	461,000	29,000	2,900
	Computer Manufacturing	$ 47.0	652,000	9,800	980
	Communications	$137.0	2,000,000	59,500	5,950
	Avionics	$ 25.0	468,000	14,000	1,400
	Laser Technology	$ 27.0	313,000	6,200	620
	Biotechnology	$ 16.0	184,000	1,800	180
	Solar Energy	$ 4.0	38,000	400	40
		$256.0	4,116,000	120,700	12,070

NOTES: 1) Employment numbers represent producers of high technology (except Computer Services)
2) Numbers may not add due to rounding

industrial training needs, particularly with regard to high technology, and how those training needs are currently being addressed. Both in- and out-of-state firms were interviewed to generate a comparison of industry perceptions toward vocational-technical training. Among the data collected was information on the use of vocational-technical school graduates, industry satisfaction with training results, perceived training deficiencies, and the extent of present industry/school interaction. These interviews were conducted with personnel familiar with industrial training needs such as training officers, personnel managers, and production managers. Table 2 profiles the companies interviewed in the survey.

To determine how they felt about the vocational-technical system in Georgia, firms were asked about their general experience with vo-tech graduates and what skills, if any, these graduates tended to lack. For the most part, firms employing vo-tech graduates felt that those skills being taught were relevant to their needs. However, many firms expressed concern regarding the depth of training these students had received, citing their lack of fundamental skills. Listed in Table 3 are the skills identified as often deficient in vo-tech graduates hired. Each deficiency is followed by a percentage reflecting the number of companies reporting that deficiency.

Deficiencies resulting from lack of basic technical skills and outdated equipment/curriculum were most often cited by Georgia high technology firms. Four companies reported general education skills deficiencies in math, science, and communication. This is a severe problem common to employers on a national scale.

Identifying industry's training needs in the area of skills required was hindered by the differences between job descriptions and Dictionary of Occupational (DOT) classifications. Obviously, this implies difficulty with providing job-specific training for every individual company's needs. However, certain basic skills through which firms can quickly orient the individual to specific job requirements are required of every technical employee. Advanced technology support requires a broad mix of skills. This implies the need for greater emphasis on cognitive rather than manipulative skills. The student that understands "why" as well as "how" will have greater flexibility in applying the skills he or she has learned to a rapidly changing job environment.

What became obvious in the overall analysis was that the firms interviewed required a mixture of electronic, electromechanical, and mechanical skills in their technical labor force. It was also revealed that engineering and scientific technicians, a classification not being trained currently in vo-tech schools in Georgia, were also in high demand. One firm estimated that it would need approximately 80 additional technicians with this training in the next five years alone. These unique training demands stress the requirement for a strong industry/school interface if industry needs are to be fulfilled.

The following problem areas in the Georgia vo-tech system were identified by the industries surveyed:

TABLE 2

OVERVIEW OF COMPANIES SURVEYED

Company	Computer Mfg/ Servicing	Communications	Avionics	Robotics & Automation	Laser Technology	SIZE			Hires Vo-Tech Graduates			In-House Training		Primary Designation	
						<100	100-1000	>1000	Yes	#	No	Yes	No	Prod	User
A	•						•		•	N/P		•			•
B	•		•					•	•	N/P		•		•	
C	•							•			•	•			•
D	•			•			•		•	15			•		•
E	•			•			•		•	4			•	•	
F	•			•			•				•		•		•
G	•						•		•	2		•		•	
H		•			•			•			•	•		•	
I	•	•	•					•	•	N/P		•		•	
J		•	•				•				•	•		•	
K	•						N/P		•	N/P			•		•
L	•						•		•	10		•			•
M	•					•			•	2-4		•			•
N	•					•					•	•			•
O	•		•	•				•	•	125		•			•
P	•		•	•				•	•	885		N/P			•
Q	•						•		•	5-6			•	•	
R				•			•		•	8-10			•	•	
S	•			•			N/P		•				•		•
T	•	•						•			•	•		•	

N/P Not Provided by Industry.

TABLE 3

TRAINING DEFICIENCIES
REPORTED BY INDUSTRY

Deficiency*	Georgia Firms	
	Number	Percent
Lack of Basic Technical Skills		
Basic electronic skills (analog)	5	31.2
DC & AC theory	1	6.2
Hexadecimal system	1	6.2
Reading schematics/prints	2	12.5
Soldering skills	2	12.5
Transistor theory	1	6.2
Understanding of Boolean algebra	3	18.8
Number of companies reporting	10	62.5
Outdated Equipment/Curriculum		
Hands-on experience	8	50.0
Experience with latest equipment	3	18.8
Computer & microprocessor languages	1	6.2
Familarity with current reference books	1	6.2
I.C. insertion techniques	1	6.2
Microprocessor interfacing	3	18.8
Number of companies reporting	8	50.0
General Education Skills		
Communications skills	1	6.2
Basic Math	2	12.5
Recordkeeping	2	12.5
Basic Science	1	6.2
Number of companies reporting	4	25.0
Other		
Interviewing skills	1	6.2
Hydraulics	2	12.5
Metallurgy	1	6.2
Pneumatics	2	12.5
Production testing	2	12.5
Tool & die	1	6.2
Troubleshooting skills	2	12.5
Number of companies reporting	6	37.5
No Deficiencies Reported	-	----
Do Not Use Vo-Tech Graduates	5	31.2
TOTAL COMPANIES	16	100.0

* Companies often cited more than one deficiency.

- Equipment - Graduates do not always have a working knowledge of equipment commonly used in high technology operations. Lack of up-to-date experience often lengthens the training period necessary for a new applicant.

- Skills - Graduates do not always possess certain basic technical and general education skills. These skills are considered extremely important in providing a foundation on which industry-specific training can be built.

- Quality of Students - Vocational-technical schools do not always attract bright, energetic students. Yet new technologies require intelligent individuals able to grasp new and complex concepts quickly. Many firms supported the concept of upgrading the image of vocational-technical education to help attract such students.

- Training Programs - Many of the larger industrial firms had internal training departments and even the smaller firms had some form of in-house training. So industries realize that the vo-tech schools cannot completely orient their programs to specific job openings. However, industry does want a worker who can easily adapt the knowledge obtained in school to new situations.

- Teacher Update - One of the major conclusions drawn from the many industrial interviews is that the success of a vo-tech program is very dependent on the presence of a capable, intelligent, progressive instructor for the subject area. According to industry, instructors should be required to spend more time in industry in order to keep up-to-date on the latest techniques and equipment. This is extremely important, and industry is encouraging the state to support this type of cooperation.

A list of typical skills required to support current high technology firms in Georgia is presented in Table 4. For the most part, these skills are not manipulative but cognitive. The vo-tech graduates of today and tomorrow will require a broader, more fundamental understanding of their fields with the ability to solve problems or troubleshoot in areas to which they were not specifically exposed during their years in school.

Skills required by industries with mid term and long term impact are not as well defined because of the innovative and changing nature of high technology use and production. Equipment will become more complex, requiring more highly skilled technicians for maintenance if not for operation. Computer and electronics applications will begin to pervade all aspects of society. Laser applications in industrial processes and energy generation may become commonplace. Biotechnology breakthroughs and the economic feasibility of solar energy will no doubt change the skills required of vo-tech graduates, but it is too early to tell in what manner. In all probability, however, the emphasis on cognitive skills versus manipulative skills will be maintained throughout the remainder of this century.

TABLE 4

SELECTED LIST OF BASIC SKILLS DEMANDED OF TECHNICIANS IN HIGH TECHNOLOGY FIRMS

1. Skill in the selection and proper use of precision electronics instrumentation, including oscilloscopes, digital voltmeters, etc.
2. Skill in assembling and troubleshooting printed circuits, wiring, and other electonic components.
3. Basic knowledge of electricity, electronics, and electronic circuits.
4. Ability to read and understand wiring diagrams, schematics, and technical specifications.
5. Skill in machine tool set up and operation, including machines equipped with CNC devices.
6. Ability to prepare logs, charts, and technical reports.
7. Understanding of shop mathematics.
8. Ability to use handbooks and chart formulas.
9. Comprehensive knowledge of electronic test theory.
10. Knowledge of structures and materials as they relate to the job.
11. Basic knowledge of hydraulics and mechanics.
12. Knowledge in geometry, trigonometry, and other related mathematical tools.
13. Knowledge in basic engineering technologies.
14. Ability to write technical reports and present technical concepts orally.

3. School System's Perspective

Inquiries into Georgia's current vo-tech system focused on seven distinct areas:

- o Educational Structure
- o Program Offerings
- o Teacher Updates
- o Industry/School Interface
- o Teacher Salaries
- o Vo-Tech Image
- o The Economy

Each of these areas was compared to systems in other selected states. As technical industry centers, California and Massachusetts are renowned for their high technology training experience. Geographically, Florida, North Carolina, and South Carolina are Georgia's greatest competition. Florida and North Carolina have well-established high technology resource centers, while South Carolina is in the process of implementing a major state plan for attracting high tech industry. Arkansas, Oregon, and Texas were selected for their innovative responses to industry training needs.

Highlights of the inquiries are shown in Table 5. Problems that other states have in common with Georgia include multi-authority governance, delays in meeting the ever-changing needs of high techology industry, and updating teachers. Other common difficulties are balancing industry's volatile and specific needs with a school system's longer range, broader based educational objectives; paying qualified instructors a competitive salary; and judiciously utilizing limited funds to provide relevant high quality programs. All of the states reported that high technology job opportunities had boosted the vo-tech image.

In addition, each of the vo-tech school directors in Georgia was surveyed by mail and nine of the schools were visited. Figure 1 shows the directors' responses to barriers perceived as hindrances to the implementation of high technology programs. Major problems involved teachers--low salaries compared with industry, certification requirements, and updating--and equipment or facilities. Sixty-two percent of the directors also perceived technical leadership at the state level as a barrier.

Shown in Table 6 are the changes required, as perceived by the directors, to bring current high technology programs up to state-of-the-art to meet the needs of existing and future industry in Georgia.

Of the 28 schools with computer-related courses, the greatest concern appeared to be for skills updating for teachers and the inclusion of new material into programs. The new curriculum guide will fill much of this gap. Even though all the vo-tech schools recently received new Burroughs computers, some need was expressed concerning other equipment updating.

TABLE 5

SUMMARY OF RESPONSES BY EIGHT STATES AND GEORGIA
TO SEVEN ASPECTS OF VOCATIONAL-TECHNICAL TRAINING

	Educational Structural	High Technology Program Offerings	Teacher Updates	Industry/School Interface	Teacher Salaries	Vo-Tech Image	The Economy
ARKANSAS	Secondary and Post-secondary training is governed by the Dept. of Education's Vocational-Technical Section.	Technical associate degrees are offered in: Electronics, Computer science, Instrumentation, And others	Certification is local and competency-based. Updating includes conferences and workshops.	Interface is provided by advisory boards, the Industry Training Program, and personnel exchange.	Special job slots at higher salaries were created by legislature. Part-time instructors from industry are often hired.	Image is being upgraded through education of guidance counselors and the public, and through interface with industry.	Arkansas is providing state funding to high tech programs but feels that this investment is wise.
CALIFORNIA	Post-Secondary vo-tech training is governed by the Board of Governors of the California Community College.	Technical associate degrees offered in: Electronics, Computer Science, Communications, Alternative fuels, And others	Certification is not required for part-time teachers most of whom are from industry.	Interface is demonstrated through a variety of advisory committees, equipment donations, and work programs.	California uses mainly part-time teachers from industry. Salaries are too low to attract good full time teachers.	Image is increasingly better due to state expenditures, innovative programs, and numerous job opportunities.	Proposition 13 has affected high tech programs, but more seriously affects secondary schools and future students.
FLORIDA	Post-secondary training is governed by the Board of Trustees and/or the local School District.	Technical two-year degrees are offered in: Computer science, Laser optics, And others	High tech instructors are judged on industry training and experience. Updating is provided on a state level but scheduled on a local level.	Advisory boards are very active, but many cooperative programs are plagued with problems.	Low teacher salaries make hiring and retaining high technology teachers extremely difficult.	Image is improving. Several new programs are exposing new students, teachers, guidance counselors and parents to vocational technical career opportunities.	The current economic situation is damaging high tech programs through loss of monies for equipment and teachers.
MASSACHUSETTS	Post-secondary training is governed by the Dept. of Education.	Technical associate degrees are offered in: Computer programming, Computer services, Computer repair, And others	Staff development is conducted through industry, but does not allow continuous updating. Approval, not certification, is used for vo-tech teachers.	The Massachusetts Council for High Technology, a consortium of over 100 firms, has been highly successful in lobbying and curriculum development.	Due to Proposition 2-1/2, no money is available for upgrading salaries even in high technology areas.	Image has improved considerably among all target groups.	Because of the depressed economy, schools are planning no new programs and are having difficulty keeping what they have.
NORTH CAROLINA	Post-secondary training is governed by the State Board of Community Colleges.	Technical associate programs in: Chemical tech, Electronics engineering technology, Computer, And others	No certification is required. Staff development is accomplished through industry updating programs and specialty conferences.	In addition to local interfacing, extensive efforts occur to increase industry/school cooperation on a state level.	Low salaries cause severe difficulties in recruitment. Although high tech teachers receive higher salaries than general teachers, salaries are still 30% to 50% less than industry.	Image has never been higher, resulting in legislative approval of the full expansion budget.	A strong financial commitment to high Technology has been repeatedly demonstrated. State officials feel the resultant influx of firms is a good return on their investment.

TABLE 5
(Cont'd)

	Educational Structural	High Technology Program Offerings	Teacher Updates	Industry/School Interface	Teacher Salaries	Vo-Tech Image	The Economy
OREGON	Post-secondary training is governed by the State Board of Education.	Technical associate degree programs are available in: Electronics; Computer/computer services; Laser optics, Spectrophysics technology; And others.	No certification is required for post-secondary vo-tech teachers. No formal updating is required by the state, so most updating is an informal return to industry.	While schools are developing working relationships with local high industries, Regional Vocational Coordinators provide a larger framework of industry/school cooperation.	While using short term instructors for industry now, Oregon's goal is a free flow of personnel between industry and schools.	Image is good because the community college system was designed to serve post-secondary vocational needs.	The worsening economy is definitely hurting vo-tech training, with lack of equipment the worst problem.
SOUTH CAROLINA	Post-secondary programs are governed by the State Board of Comprehensive and Technical Education.	Five resource centers in existing schools are planned in: Computer applications; Electronics; Robotics; Future office occupations; Advanced machine shop	Certification procedures do not affect technical instructors. Staff development is handled through industry seminars and conferences.	Interfacing is encouraged through active Advisory Boards, personnel exchange, and cooperative internships.	Unable to raise low teacher salaries presently, South Carolina hopes to attract teachers through interest in the "Design for the Eighties" Concept.	As a result of hard work by vo-tech schools, image has increased considerably in the past five years.	Funds to implement the five resource centers are "on hold" until interest rates go down.
TEXAS	Secondary and Post-secondary training programs are governed by the State Board of Education.	Two-year degrees offered in: Alternative energy; Computer applications; Electronics; Laser/optics; Communications	Credentialing replaces certification. Updating is accomplished through specialized workshops at both local and state levels.	All interfacing takes place at a local level. Cooperative internships are most prominent.	Teacher salaries have been raised considerably but high technology instructors still may make 50% less than they would in industry.	Image is generally good, particularly for post-secondary programs.	Texas is unique in that their economy is booming. Thus high tech programs are expanding rapidly.
GEORGIA	Secondary and post-secondary programs in vo-tech schools are governed by the Department of Education. Training at Junior Colleges are governed by the Board of Regents.	Programs available in: Computer tech; Drafting; Electrical tech; Electro-mechanical; Industrial electronics; Instrumentation tech; Machine & tool design; Machine shop; Mechanical tech	Certification requirements are the same as those for secondary teachers, including 30 hours of education courses in the first 3 years. A new emphasis on staff development for high tech teachers is shown through special in-service conferences, programs, and state regional seminars.	State and local advisory councils provide guidance while the High Technology Coordinator will provide overall interface. Locally cooperation includes work experience programs for updating teachers. Equipment donations and joint programs are expected to increase	Low teacher salaries act as a severe barrier to high tech implementation.	Traditionally viewed as "trade schools", Georgia's vo-tech schools are quickly gaining credibility due to recent improvements and recognition of present high technology program achievements.	The poor economy is not affecting Georgia as badly as other states, but economies are still very necessary. High technology programs were recently awarded $8.0 million to upgrade electronics, mechanical, and electromechanical programs.

FIGURE 1

BARRIERS PERCEIVED BY AREA SCHOOL DIRECTORS

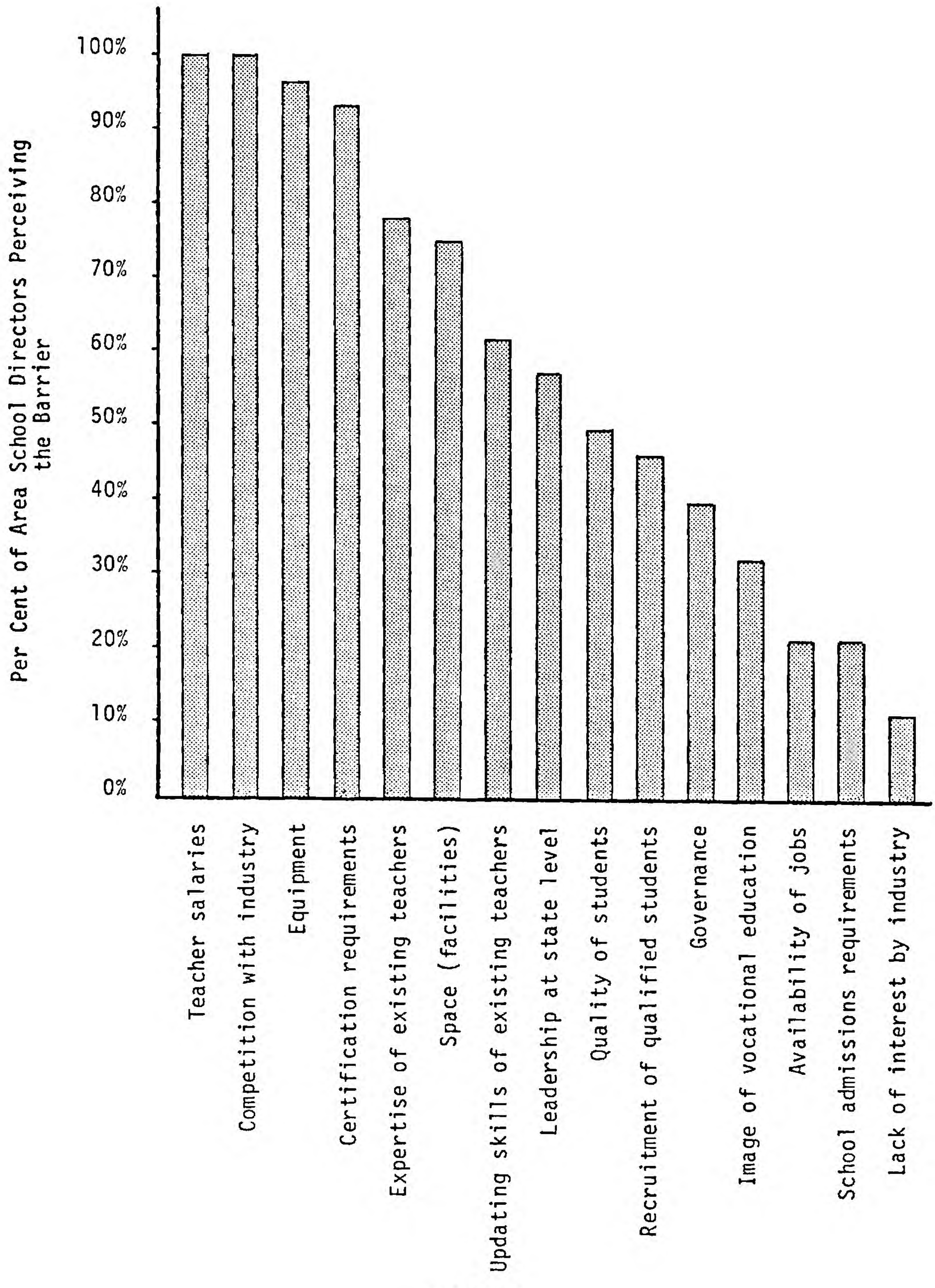


TABLE 6

VOCATIONAL-TECHNICAL SCHOOL DIRECTORS' EVALUATION OF CHANGES NECESSARY TO BRING HIGH TECHNOLOGY COURSES TO STATE-OF-THE-ART (PERCENTAGES)

High Technology Area	Number of Programs	Develop New Curriculum	Hire Qualified Teachers	Obtain Additional Funding	Update Skills	Add Courses	Eliminate Courses	Update Equipment
Computer-Related Technologies	28	50.0	19.2	42.3	53.9	46.2	7.7	38.5
Electronics Technology	23	52.2	13.0	65.2	73.9	65.2	21.7	73.9
Electromechanical Technology	12	58.3	33.3	58.3	58.3	58.3	16.7	75.0
Drafting Occupations	22	75.0	27.3	54.6	54.6	54.6	18.2	68.2
Mechanical Technology	10	50.0	40.0	90.0	80.0	60.0	30.0	90.0

In electronics technology courses offered at 25 schools, skills updating was the most frequently cited need. Due to rapid technological developments in this field, equipment updating and adding new course material were also concerns. The need expressed for additional funding is, of course, related to directors' continuing concern regarding their schools' ability to produce highly qualified technicians in this high demand field.

Electromechanical technology, a newer program, is offered at 12 schools. Needs for a new curriculum and equipment updating were expressed by vo-tech school directors. The new curriculum guide planned will offer further direction for the necessary updating of teacher skills.

Programs in various drafting occupations are offered at 24 schools. Some concern is expressed concerning the need for equipment updating, particularly as a result of CAD (computer-aided design) systems. Industry presently has few complaints concerning graduates from these programs. Students know the basics, so industry generally completes the orientation to necessary equipment on-the-job.

Mechanical technology, including those machine shop programs considered high technology by school directors, are offered in only 10 schools. Updating teacher skills and equipment were of greatest concern to directors. Again, the need expressed for additional funding is related to continuing concerns regarding the ability to produce adequately trained technicians to meet anticipated industry demand.

In summary, strengthening curricula, updating teacher skills, and updating equipment were the greatest needs expressed by school directors in order to upgrade and/or maintain present high technology training programs at a level to implement Georgia's dual economic strategy. These items must remain high priority if the Georgia vocational-technical education system is to be competitive with that of other states in attracting new industry and maintaining the viability of existing industry.

4. Barriers

Discussions with industry training personnel, school directors, and high technology administrators in other states pointed out the following major barriers to implementation of effective high technology programs in vo-tech schools:

INDUSTRY AND SCHOOLS

Lack of up-to-date equipment
Inadequate teacher updating
Quality of students

INDUSTRY ONLY	SCHOOLS ONLY
Basic skills not taught	Low teacher salaries
Slow response to needs	Competition with industry for teachers
	Funding/the economy

In addition, 96% of the Georgia school directors perceived certification requirements as a major barrier, and 62% cited lack of technical leadership at the state level.

C. NEEDS

1. Programs

Comparing industry comments on skill deficiencies of current vo-tech graduates with the current programs and curriculum guides used by Georgia teachers shows that many of the deficiencies are due not to the lack of understanding by teachers of what is needed but rather to the lack of instructor updating and equipment. Deficiencies reported most often were lack of basic electronic skills, knowledge of Boolean algebra, microprocessor interfacing, and hands-on experience with the latest equipment. The current programs in Electronics Technology, Electromechanical Technology, and Mechanical Technology are reasonably well-suited to providing these skills required by industry. A modular approach where fundamentals are taught in the first five or six quarters with specialization in the last few quarters would provide a more flexible program; changes in technology would necessitate only a revamping of the the last few modules. For example, an electronics program would provide courses such as electronics fundamentals, basic circuits, and microprocessor fundamentals in the first phases, with typical specializations in the last phase of industrial electronics, computer applications, communications, or avionics depending on what the student was interested in or what jobs were projected to be available in high technology producer or user industries.

One curriculum area that has been lacking but is now projected for inclusion into the associate degree pilot program is general education skills--math, physics, and technical writing. Need for these courses stems from the emphasis on cognitive versus manipulative skills mentioned earlier.

Accreditation Board for Engineering Technology (ABET) requirements include a minimum of 100 quarter hours with 50 hours in technical areas, 25 hours in basic science and math, and 14 hours in communication, humanities, and social sciences. According to the Preliminary Curriculum Planning Guide (1982) for engineering technology programs prepared by Georgia State University and the Center for Occupational Research and Development, heavy emphasis will be placed on laboratory contact hours.

Mid term and long term program needs will need to be closely coordinated with industry as projected trends evolve into bonafide employment opportunities. Industrial automation and laser technology are deemed significant enough to begin now in formulating an approach to program offerings. Gathering materials and setting up a framework so these would be ready to implement on a year's notice could help attract new industry to the state or be enough impetus to an existing industry to revamp their production processes. There is some risk involved in setting up a program before actual jobs are established. However, it is a risk that should be considered in order to meet high technology industry needs of the future.

2. Delivery Systems

New delivery systems need not be developed for teaching high technology. No one "best" delivery system emerged from this study. Instead, the major concern is how to locate delivery systems to best satisfy the needs within cost constraints. Student skills, subject area, and teacher preference impact the choice of delivery system. But overall cost and demand should be the major decision factors in developing individual delivery systems at the school level.

Laboratory simulation, OJT (on-the-job training), and classroom lectures are preferred by vo-tech educators because of the students' needs for interactive reinforcement. Videotape and other audiovisual media are preferred by industry where students are more experienced and subject areas more specialized.

As far as the "basic skills" curricula and instrumentation are concerned, a permanent program at every school is needed. However, with regard to teaching more specific job training skills, the programs should be taught only in those schools at which a definable need exists. Equipment to support these programs should be permanently installed at schools with high enrollments, and a time-sharing arrangement should be utilized at schools with lighter enrollment.

Mobile laboratories, while cumbersome to manage and schedule, provide an opportunity to share expensive equipment across the state, thereby helping to hold down overall costs. Industry facility usage represents an attractive substitute for mobile, time-sharing use of state equipment, assuming local industries will cooperate in making their facilities available for such training. Off-campus programs at industrial sites, while typically the least expensive, require scheduling at odd hours and will likely encounter resistance on the part of industries because of the high cost of maintenance resulting from inexperienced operator use of machinery.

Table 7 displays the recommended delivery system combinations appropriate to each of the three fundamental training programs scheduled for upgrading: Electronics, Electromechanical, and Mechanical Technology.

3. Equipment

The top four industrial areas predicted to have significant impact on Georgia in the near term have one common element: electronics. It is therefore appropriate to upgrade electronics equipment in all existing programs. Costs for training equipment considered a basic mininum requirement for Electronics Technology would run about $100,000 per school. Costs for state-of-the-art programs such as those being implemented in the three pilot schools would run an additional $260,000 per school.

Addressing the needs for industrial automation would require upgrading equipment in Mechanical and Electromechanical Technology programs. Equipment needs for basic minimum and state-of-the-art Mechanical Technology

TABLE 7

RECOMMENDED DELIVERY SYSTEMS

TECHNIQUE	COMMENTS
Electronics	
Preferred: Classroom instruction augmented by lectures, laboratory simulators, and OJT. All schools fully equipped for programs offered.	The fact that electronics is the heart of high technology and that few, if any, equipment items are big ticket (< $100,000), suggest all Vo-Tech schools should eventually be fully equipped with analytical and instructional electronic equipment. True, some will become outdated, but many will have long lives (5-10 years). This cost can be offset by extending part of the teaching load to instructors provided by industry and by seeking industry and federal support. All other aspects appear feasible from industry response except funding.
Options: Same as preferred without fully equipped programs in all schools.	This option would reflect an inability to fully fund equipment purchases. It has a lower cost but also weakens the image and effectiveness of the entire system.
Same as preferred but with equipment sharing among schools.	In the case of electronics equipment, sharing equipment is a poor choice. Most instrumentation is delicate and vulnerable to theft.
Electromechanical	
Preferred: Classroom instruction augmented by lectures, laboratory simulators, and OJT. Many schools fully equipped, with marginal programs (from an attendance perspective) sharing industrial equipment.	Electromechanical technology approaches an area where overall equipment expense can be quite high. Furthermore, electromechanical equipment can get quite specialized. While the other aspects of delivery do not need to differ from the electronics approach, using industry equipment on-site coupled with Vo-Tech trainers should offer the most cost effective delivery of this program.
Options: Same as preferred except with mobile facilities to share high cost items among schools.	Logical solution where industry equipment is non-existent or unavailable. However, there are costs and risk associated with transporting equipment around the state. This option, therefore, is not very attractive.
Same as preferred except with select schools being outfitted with equipment items made available to other schools who can transport students to facilities for training.	Alternative to above but with problems of its own in terms of operating cost and scheduling. However, this option would be less costly than the one above.
Mechanical	
Preferred: Classroom instruction augmented by lectures, laboratory simulators, and OJT. Many schools fully equipped, with marginal programs (from an attendance perspective) sharing industrial equipment.	Mechanical training in such areas as machine tooling, casting, etc., require substantial capital outlay in equipment. Fortunately, this technology has not changed as substantially as the electronics area. Consequently, much of the existing equipment can be expected to remain up-to-date for years to come; and, therefore, more schools have a chance to have equipped programs. Nonetheless, industry augmentation of areas where school equipment is outdated is the lowest cost method of rounding out a training program.
Options: Same as electromechanical above.	Same as electromechanical above.

programs, are approximately $390,000 and $370,000, respectively, per school. Electromechanical Technology equipment costs would be $460,000 for a basic level program and an additional $243,000 for the pilot level program. However, there is some duplication of equipment because it is a hybrid of the Electronics and Mechanical Technology programs. Costs are summarized in Table 8.

4. Staff

There is a critical shortage of qualified teachers to support key high technology courses. This shortage seems to be the result of teachers being both underpaid and overworked. Vo-tech teachers in the Georgia education system often have highly marketable skills which place them in high demand by industry. Accordingly, they command a high salary in the marketplace. Yet teachers in the vo-tech system are paid very low salaries in proportion to their market worth. A significant annual increase in supplemental wages paid to high technology teachers would be required to raise existing average salaries to the range competitive with industry. System constraints frequently prevent salary adjustment; consequently, it is difficult to attract and retain qualified teachers.

Higher salaries alone, however, will not provide a strong teaching staff. Currently, teachers spend an average of 30 hours per week in teaching and counseling duties. Since this leaves very little time for instructors to keep up-to-date with changes in their respective fields, a mechanism for allowing teachers more time for industry interaction is required. Periodic leaves of absence would provide vo-tech staff with the opportunity to work in an appropriate industrial setting, thereby familiarizing themselves with new equipment and technological changes.

High technology by definition is dynamic and ever-changing, and high technology teachers require frequent exposure to refresher courses on the latest developments. A recommended training center for high technology vo-tech school teachers could provide special training in high technology areas by both educational and industrial personnel. This training should be designed to complement, not duplicate, vo-tech teacher training presently offered by the University of Georgia and Georgia State University.

The major activity at this center should be the development and provision of specialized short courses aimed at upgrading or refreshing the knowledge and skills of teachers in the high technology fields. Emphasis should be on those fields with substantial current and projected needs for skilled technicians. Courses should be presented at times convenient to vo-tech teachers and provide intensive technical theory and practical applications. Training center facilities should include laboratories for hands-on training, classroom and conference areas, sophisticated media equipment, and a library housing an extensive and constantly updated data collection.

TABLE 8

REPRESENTATIVE EQUIPMENT NEEDS

	Funding
Basic Level	
ELECTRONICS TECHNOLOGY	$ 99,450
ELECTROMECHANICAL TECHNOLOGY	464,900
MECHANICAL TECHNOLOGY	388,800
	953,150
Pilot Level	
ELECTRONICS TECHNOLOGY	260,360
ELECTROMECHANICAL TECHNOLOGY	243,000
MECHANICAL TECHNOLOGY	370,000
	$873,360

NOTE: These are lists of suggested equipment considered to be a minimum requirement to carrying out basic and pilot level programs.

D. RECOMMENDATIONS

Recommendations designed to facilitate effective implementation of high technology programs by meeting overall system needs, program needs, and staff needs are presented in the following pages. Due to the rapidly changing nature of high technology, these recommendations emphasize the need for continual updating of a flexible and systematic plan rather than designating specific steps according to a rigid time line.

1. System Needs

ISSUE: Of numerous siting requirements expressed by high technology industries, ability of a state's vocational-technical school system to train quality technicians is of primary importance. Quality education is the result of good planning, which in turn results from accurate and timely analysis of relevant conditions and data. Because of the rapid changes inherent in high technology fields, the necessity for continual information and analysis is even greater.

RECOMMENDATION: Establish a group to provide continual strategic intelligence on high technology trends as support to the High Technology Advisory Council. Areas should include:

- **Projected job openings in various high technology fields**
- **Projected training needs**
- **Technical developments, both new and successfully implemented**
- **Specific curriculum updating needs**
- **Specific teacher update needs**

ISSUE: High technology training programs must respond quickly to changes in training needs due to technological advances, new occupations, and the disappearance of specific skills or entire fields. This requires complete program coordination, from high school vo-tech courses to associate degree programs, and the ability to adjust program offerings quickly and efficiently.

RECOMMENDATION: Study Georgia's system of governance to determine the most effective means of providing governance to vocational-technical education efforts, particularly in high technology areas. Utilize the High Technology Training Coordinator as a liaison to ensure continual contact and cooperation among all concerned with the provision of quality technical training.

ISSUE: A cooperative relationship between schools and industry is necessary for communication of training needs and capabilities. A High Technology Advisory Council has already been formed, but can provide even greater assistance by actively participating in efforts to coordinate the state governing bodies, intelligence system, curriculum development committees, high technology industry and schools.

RECOMMENDATION: Encourage industry involvement in the training process through statewide or local:

- **Assistance in curriculum development**
- **Donation or loan of state-of-the-art equipment**
- **Exchange of personnel between schools and industry**
- **Development of cooperative work experience programs**
- **Funding of a high technology training "chair" or position in the vo-tech school**
- **Involvement in expanded "career day" activities**
- **Formation of programs to encourage mastery of basic skills (math, science, communications) in lower grades**

2. Program Needs

ISSUE: Program offerings in high technology fields are particularly vulnerable to obsolescence. Need for one skill may diminish while demand for an entirely new skill evolves due to technological advances.

RECOMMENDATION: Update program curricula based on information provided by the intelligence gathering group. Investigate curriculum needs based on long range forecasts and develop programs based on mid range forecasts so that capability to train can be used as a selling point in attracting new industry to the state.

ISSUE: The high technology technicians of today require more problem-solving abilities because of the rapid changes taking place. They must be able to adapt their knowledge to new situations. This places greater emphasis on cognitive skills rather than the manipulative skills traditionally taught by vo-tech schools and requires a more in-depth understanding of math and science fundamentals. Although the Interim Report recommended that two-year degrees be implemented over the long term, more immediate action has been taken by the State Board of Education. The accelerated development and implementation of a two-year degree program in high technology areas should not ignore the need to secure the support and co-operation from industry, accrediting agencies, and other appropriate organizations.

RECOMMENDATION: Set up a formal arrangement between the State Board of Education and the Board of Regents to cover the granting of two-year technical associate degrees.

ISSUE: An innovative training approach represents a vital, flexible training system. Continually changing training needs, availability of funds, and varying levels of industry involvement require constant monitoring and response. Data on these aspects and potential methods of addressing specialized needs will be supplied by the previously mentioned intelligence group.

RECOMMENDATION: **Develop an innovative training approach to address established needs by offering:**

- **Courses at various hours, including evening, late night, weekend or split work/school schedules**
- **Courses at convenient locations, based on local conditions**
- **Programs with more cooperative work experience than usual or more concentration on basic skills**
- **A statewide placement service for the convenience of both industry and students**

ISSUE: In order to fulfill the need for technicians in high technology industry, retraining programs must also be offered. Several programs in other states have demonstrated successful high technology training programs for unemployed workers. Also industrial automation will necessitate the establishment of systematic retraining programs so current employees can be updated on new techniques and/or equipment.

RECOMMENDATION: **Provide opportunities for retraining to both the unemployed and currently employed workers needing updating. Establish a structure and develop annual plans for implementing the programs.**

ISSUE: In order to be completely trained as high technology technicians, students must have access to state-of-the-art equipment. The $8 million appropriation is a needed boost. However, options must be put in place now to deal with equipment shortages in the future.

RECOMMENDATION: **Implement procedures to furnish student access to state-of-the-art equipment through:**

- **Systematic purchase plans**
- **Statewide or regional equipment pools**
- **Lease of equipment**
- **Solicitation of industry-donated equipment**
- **Use of equipment in industry through special arrangement for classes**
- **Use of equipment in industry through cooperative work experience programs**

3. Staff Needs

ISSUE: Continual updating of teachers' knowledge and skills is necessary to provide high quality, relevant training programs.

RECOMMENDATION: Establish a central training center to provide a variety of updating opportunities for high technology teachers including:

- o Workshops, seminars, and conferences
- o Short-term updating in industry
- o Shared personnel between schools and industry
- o Distribution of publications concerning technical advances, new training equipment, skills necessary to use state-of-the-art equipment, and educational opportunities

ISSUE: Qualified vocational-technical teachers are extremely difficult to find, and this is particularly true of high technology teachers. Low teaching salaries are the major impediment. Industry personnel in high technology fields must take a substantial pay cut in order to teach.

RECOMMENDATION: Implement the following options to provide higher salaries and incentives to attract high technology teachers:

- o Legislature creation and funding of special job slots
- o Full or partial salary support by industry of either chairs or individuals
- o Personnel sharing with industry

ISSUE: If high technology teachers are to stay updated in their profession, they must spend a significant amount of time keeping abreast of new developments in their field.

RECOMMENDATION: Revise certification/recertification requirements to reflect specialty updating requirements for high technology teachers. Institute appropriate requirements for part-time teachers from industry. Reduce the teaching load from 30 hours per week for full time teachers to permit more significant updating opportunities.

Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of the Educational Amendments of 1972 and Title II of the Vocational Educational Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.

Employees, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.

The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy.

Title II - Loydia Webber, Vocational Equity Coordinator
Title VI - Peyton Williams, Jr., Associate Superintendent of State Schools and Special Services
Title IX - Evelyn Rowe and Myra Tolbert, Coordinators
Section 504 - Jane Lee, Coordinator of Special Education

Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, State Office Building, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.